THE POLYZOA OF THE SIBOGA EXPEDITION

PART II

CHEILOSTOMATA ANASCA

(WITH ADDITIONS TO PREVIOUS REPORTS)

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THE

POLYZOA OF THE SIBOGA EXPEDITION

BY

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PART II

CHEILOSTOMATA ANASCA

(WITH ADDITIONS TO PREVIOUS REPORTS)

With 22 plates and 23 text-figures

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PART II

CHEILOSTOMATA ANASCA.

(WITH ADDITIONS TO PREVIOUS REPORTS.)

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I. INTRODUCTION.

The preparation of Part II of my Report has been long delayed, owing to the War and to official duties which have had a claim on my time. The present part deals principally with the Cheilostomata Anasca, but it is necessary to make a few additions to Part I, and I give also several new records of *Rhabdopleura*, a genus which was included in my Report on the Pterobranchia, on the evidence of fragmentary specimens from Stat. 204. In mentioning *Rhabdopleura* in this place I wish to guard myself against the possible inference that I suppose it to be in any way connected with the Polyzoa, a group to which the Pterobranchia are, in my opinion, not allied. It is included simply for reasons of convenience.

The additional records are almost entirely due to the kindness of Prof. A. BILLARD, who sorted out and sent to me many specimens which had been found by him among the Hydroids entrusted to him for description. All specimens numbered from 584 onwards were received in this way. Most of the species represented in Prof. BILLARD's consignments had already been found by me in material from the same Stations; and in many cases I have merely added his specimens to those I already had from the same dredgings. One or two species, however, and notably a very interesting new species of *Amathia* and *Calyptozoum*, an even more remarkable Cheilostome (Bicellariellidae), representing a new genus, have been found as the result of the trouble taken by Prof. BILLARD.

I include in this Report specimens from Torres Straits, Singapore and Japan belonging to the University Museum of Zoology, Cambridge, as indicated on p. 3 of Part I of my Report. The more important of the specimens previously described have now been transferred to the British Museum, and by an arrangement kindly made by Mr. C. FORSTER COOPER, the Superintendent of the Cambridge Museum, the same procedure will be adopted with regard to some of those now under consideration. The slides which it is thus proposed to transfer to the British Museum are indicated by the letters BM.

II. PTEROBRANCHIA.

Additional specimens. See Monogr. XXVI*bis*, 1905, Pterobranchia, p. 125. Stations from which the species were not there recorded are marked *.

Rhabdopleura annulata J. R. Norman.

Rhabdopleura indet. Harmer, 1905, *l. c.*
Rhabdopleura annulata J. R. Norman, 1921, Brit. Antarct. (Terra Nova) Exp. 1910, Zool., IV, N° 4, p. 98. N. of New Zealand, 183—549 M.

396. V.
646. A. } Stat. 162*. Off Loslos Id, N. end of New Guinea, 18 M.
657. A.

612. B.
635. A. } Stat. 163*. Seget, N. end of New Guinea, 29 M.

566. B. Stat. 204. Between Wowoni and Buton, S. E. Celebes, 75—94.

It may be inferred from these records that *Rhabdopleura* is common at Stations 162 and 163 at least. The small depth at which specimens were found is of interest, and their bathymetrical distribution thus corresponds with that of *Cephalodiscus*, which is mostly a deep water form in Antarctic localities, but was recorded in my Siboga Report (p. 7) from quite shallow water, just N. of the Equator.

The new specimens are considerably larger than the fragments previously described, and the peristomes, or free parts of the tubes, may have more numerous rings (as many as 70), reaching a length of at least 2.6 mm. and a diameter of 0.32 mm. The zooids are for the most part in good condition. In one or two cases I have observed a single testis, forming a hernia-like prolongation coming off from the body, at its junction with the stalk, as described by LANKESTER (1884, Q.J.M.S., XXIV, p. 633) and SCHEPOTIEFF (1906, Zool. Jahrb. Abt. Anat., XXIII, p. 508). I agree with Mr. J. R. NORMAN in thinking that the Siboga material is to be referred to *R. annulata*, the distinguishing features of which he has well described. The most striking of these is the sharply projecting distal edge of each of the peristome-rings, as figured by me in my earlier Report.

III. POLYZOA.

Sub-Class II. **ECTOPROCTA.**

Tribe 1. GYMNOLAEMATA.

Order I. CTENOSTOMATA.

Additional specimens. See Monograph XXVIII*a*, 1915, Polyzoa, Part. I. Stations from which the species were not there recorded are marked *.

In Part I of my Report I regarded the Sub-Class Ectoprocta as divisible into two Orders; — (1) the Gymnolaemata, and (2) the Phylactolaemata, which are not represented in the Siboga Collection. As it now seems to me desirable to treat the three principal groups of marine Ectoprocta as Orders, it is necessary to assign a higher taxonomic rank to the Gymnolaemata and Phylactolaemata, which may be designated as Tribes. The recent marine Families may then be arranged in three Orders, the Cyclostomata, Ctenostomata and Cheilostomata, of which I think the Cyclostomata should have been placed first.

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53. *Nolella papuensis* (Busk). 655. A. Stat. 50.
Nolella papuensis (Busk). 592. A. Stat. 71.
Nolella papuensis (Busk). 614. A. Stat. 162.
Nolella papuensis (Busk). 648. B. Stat. 164.

61. *Vesicularia papuensis* Busk. 654. B. Stat. 273.

64. *Amathia convoluta* Lamx. 595. B., 663. A. Stat. 99.
Amathia convoluta Lamx. 591. A, 607. A. Stat. 273.
Amathia convoluta Lamx. 608. A. Stat. 274.
Amathia convoluta Lamx. var. *semispiralis* Kirch. 647. A. Stat. 164.

68. *Amathia distans* Busk. 606. B. Stat. 7, reef.

70. *Bowerbankia imbricata* (Adams). 645. A. Stat. 162*. Off Loslos Id, N. end of New Guinea, 18 M. Some of the zooecia contain a large embryo in the tentacle-sheath, the rest of the polypide being more or less degenerated.

73. *Valkeria atlantica* (Busk). 396. R. Stat. 162. On the Hydroid *Synthecium patulum* (Busk), determined by Prof. BILLARD.
Valkeria atlantica (Busk). 501. H. Stat. 163.
Valkeria atlantica (Busk). 648. C. Stat. 164.

76. *Valkeria tuberosa* Heller. 505. B. Stat. 164.

79. *Mimosella bigeminata* Waters. 612. C. Stat. 163*. Seget, N. end of New Guinea, 29 M.

81. *Mimosella verticillata* (Heller). 648. A. Stat. 164.

87. *Buskia setigera* Hincks. 339. B. Stat. 71.
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Buskia setigera Hincks. 631. A. Stat. 258*. Kei Is., 0—22 M.

1. *Amathia vermetiformis* n. sp. (Pl. XIII, figs. 1, 2).

Type. 598. B. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
629. A. Stat. 164. W. of. N. end of New Guinea, 32 M.

Zoarium reaching a length of about 62 m., not greatly branched. Chitin of stem thick

proximally, where numerous rootlets attach it to the ooze; delicate in distal parts of colony. Stem septate at intervals. Zooecia biserial, arranged in an elongated spiral of many turns, not interrupted at the septa in unbranched parts of the stem; their orifices not produced, situated in a double line, in the mature condition near the middle of the exposed part of the spiral. Branches given off, as in *A. convoluta*, on one side only, close to a stem-diaphragm, on its proximal side. At the growing tips the zooecial spiral is tightly wound, its successive turns in lateral contact, so as completely to conceal the stem, which becomes exposed with further growth by the elongation of the spiral. The branch is developed while the growing tip is still closely wound, appearing first as a lateral papilla of the parent spiral (Fig. 1) and later as a spiral resembling that of the main stem (Fig. 2). Tentacles 8.

I owe the specimens of this remarkable species to Prof. BILLARD, who sorted them out of the Hydroid collection. The trivial name is suggested from the resemblance of the growing tips to the shell of the Mollusc *Vermetus*, in which the spiral is similar both distally and proximally.

A. vermetiformis differs in the form of its growing tips from any other species of the genus with which I am acquainted. The much elongated spirals of the older parts may have as many as eleven turns, and they are remarkable for passing without interruption across the diaphragms of the stem. They come to an end at a bifurcation, after which the stem of each branch is bare for a short distance before the spiral re-commences (Fig. 1). The radial diameter of the spiral is small, and there is no interruption of its uniform curve in the region of the orifices, which are not separated by a distinct groove. The retracted polypides lie more or less longitudinally, directed towards one another in the two series, and thus having their orifices in two closely approximated lines. At the growing tips of the branches the orifices are at the distal margin of the turn of the spiral, becoming shifted to their adult position as growth proceeds. The zooecia of the proximal row are more developed than the distal members, in the young condition. The rootlets are given off in considerable numbers from the proximal parts of the stem, each originating from an oval area, limited internally by a convex, watchglass-like septum lying in the body-cavity. The first part of the rootlet is a short and narrow, cylindrical tube, which gives off a whorl of very delicate branches at its end, and is sometimes prolonged as a main rootlet beyond the origin of its branches. Rootlet-bases of this kind are found in the more distal parts of the colony, principally at the proximal ends of the internodes, but they appear not to give rise to rootlets in parts where these structures are not required for attachment. The zooecia are commonly lost in the proximal parts, where there are considerable lengths of bare stem.

Order III. CHEILOSTOMATA.

Cheilostomata Busk, 1852, J. MACGILLIVRAY's "Voy. 'Rattlesnake'", I, p. 346.
Cheilostomata Busk, 1859, "Monogr. Foss. Pol. Crag", Palaeont. Soc., p. 9.
Cheilostomata Levinsen, 1909, "Morph. Syst. Stud. Cheil. Bry.", p. 91.

A. TERMINOLOGY.

Ancestrula. — The first zooecium of the colony, formed by the metamorphosis of the larva.
Aperture. — The opening occupied by the frontal membrane.

Ascopore. — The opening of the compensation-sac in Microporellidan Ascophora.

Blastozooid. — A zooecium produced as a bud.

Cellariiform. — Used to describe a jointed zoarium with more or less cylindrical branches in which the orifices are arranged on all aspects of the curved face of the cylinder.

Compensation-sac (of Ascophora). — A membranous sac on the basal side of the frontal shield, opening to the exterior at or near the proximal border of the operculum.

Costa. — A modified spine overarching the frontal membrane in Cribrilinidae, usually uniting with neighbouring costae.

Cryptocyst. — A more or less horizontal, calcareous lamina, on the basal side of the frontal membrane, developed from the vertical walls of the zooecium, but not completely subdividing its body-cavity.

Dietella. — Used by Canu and Bassler as the equivalent of pore-chamber (*q. v.*).

Ectooecium (= ectoooecium Levinsen). — The outer layer, frequently calcareous, of an ovicell (see p. 201).

Entooecium (= endoooecium Levinsen). — The inner, calcareous, layer of an ovicell (see p. 201).

Entozooecial (= endozooecial Levinsen). — Used to describe an ovicell which appears to be immersed in the distal zooecium (see p. 202).

Escharan. — Used to describe a bilaminar colony in which the orifices of the two layers face in opposite directions.

Frontal membrane. — An uncalcified part of the body-wall filling the aperture.

Frontal shield. — A calcareous layer, formed in various ways, outside the frontal membrane, from which it is separated by a space, the hypostegia.

Gymnocyst. — The part of the body-wall (not always present) which lies between the aperture and the free edges of the vertical walls, usually most developed on the proximal side of the aperture.

Hemescharan. — Used to describe a free unilaminar colony in which all the orifices open on one surface.

Heterozooecium. — Used by Levinsen for a modified zooecium, such as an avicularium or a vibraculum.

Hyperstomial. — Used to describe an ovicell lying on the distal side of the orifice and developed outside the zooecium.

Hypostegia. — Used by Jullien for the cavity between the frontal shield and the frontal membrane; probably homologous with the cavity of the compensation-sac in Ascophora.

Kenozooecium. — Used by Levinsen for a reduced zooecium without polypide or operculum, rarely with any indication of an orifice.

Marginal spines. — The spines other than the oral spines (*q. v.*) which surround the aperture.

Opesia. — Used by Jullien for the opening connecting the parts of the body-cavity on the basal and frontal sides of the cryptocyst.

Opesiule. — An open or closed sinus of the cryptocyst, transmitting a muscle which depresses the frontal membrane.

Oral spines. — Spines developed on the distal and lateral sides of the orifice.

Orifice. — The opening of the tentacle-sheath, in Cheilostomata nearly always guarded by an operculum.

Pore-chamber. — Used by LEVINSEN for a cavity between the basal parts of the vertical walls of two contiguous zooecia, with which it communicates by means of pores.

Rosette-plate. — An area in the wall separating two zooecia, pierced by pores. The term refers primarily to a multiporous area, and is strictly not applicable to a uniporous area (see *septulum*).

Sclerite. — A chitinous thickening; used in the description of opercula and mandibles.

Septulum (= septula, JULLIEN). — A communication-pore perforating the wall separating two zooecia; here restricted to monoporous "rosette-plates".

Vincularian. — Used to describe an unjointed zoarium with cylindrical branches in which the orifices are arranged on all aspects of the curved face of the cylinder.

B. Bibliography.

Comparisons with the results of earlier authors are difficult to follow without satisfactory references, but to give these in full on each occasion needs an inordinate amount of space. I have accordingly adopted a system of shortened references, based on that used by Messrs HERON-ALLEN and EARLAND (Trans. Zool. Soc. London, XX, Pt XVII, 1915, pp. 756—766), but differing from it in some details. The text contains these references, which are explained in an alphabetical Bibliographical list at the end of the Report. In cases where the Volume or Part of a serial is given in the text, the abbreviation will be found in its proper place in the alphabetical list. Where no such indication is included in the text, the explanation of the abbreviation will be found under the author's name. I have included in the Bibliography full references to most of the papers which are important, in the present connexion, by reason of the fact that they are concerned with the Malay Region or neighbouring seas, or for some other special reason. It is hoped that the abbreviations used will be sufficiently intelligible to make it unnecessary, in most cases, to turn to the list at the end of the Report.

C. Nomenclature and Classification.

The genera of Polyzoa are at present in a very confused state, due partly to the want of correlation, but to a large extent to the fact that many species have been placed in genera to which they cannot properly be referred according to the accepted Rules of Nomenclature. It is impossible to decide the correct use of a generic name without knowing which species should be considered the genotype. I have endeavoured to follow this principle throughout, and I have already cleared some of the ground by discussing (1923, JLS, XXXV, pp. 297—317) the genotypes of the Cellularine Polyzoa and certain others.

Sub-Order I. ANASCA.

Anasca Levinsen, 1909, MSSB, pp. 12, 88, 91.

Cheilostomata with no compensation-sac, the frontal membrane (frequently reduced) retaining its primitively external position, unless concealed by costae, in which case the hypostegia may acquire the character of a compensation-sac.

The classification of the Cheilostomata adopted in this Report follows in the main the arrangement proposed by Levinsen (1909, MSSB, pp. 88 *et seq.*), whose conclusions had been influenced to some extent by my own earlier paper (1902, QJMS, XLVI, p. 263), as is shown by his preliminary account (1902, VMNFK, p. 1). I am not completely in agreement with him, however, as to the position of certain Families, and I suggest a different grouping of some of them.

Levinsen divided the Order Cheilostomata into two Sub-Orders, the Anasca (with which this Part of my Report is alone concerned) and the Ascophora, the second characterised principally by the presence of a compensation-sac. The Anasca are typically without this organ, but their last Division, the Cribrimorpha, which may be regarded as transitional to the Ascophora, have it at least indicated and in some cases well developed. The compensation-sac of these Anasca is formed in ontogeny, however, in a manner which differs from its mode of development in the Ascophora, as explained below, under the Cribrilinidae.

Division 1. Inovicellata.

I adopt Jullien's Division for the Aeteidae, the isolated position of which has been recognised by most authors. There is no evidence that ovicells of a typically Cheilostome nature are present in this Family, which seems to represent a stage in evolution antecedent to the appearance of these structures. The Aeteidae are further of interest in showing an approach to the Ctenostomata in certain features, and I think this resemblance can be explained by regarding them as the representatives of the ancestors of the Stoloniferous Ctenostomes, rather than by supposing the Ctenostomata to be the ancestors of any members of the Cheilostomata. If this is a correct conclusion, it probably follows that the Alcyonidiidae, and perhaps some other Ctenostomes, have had an independent origin, from Membraniporine forms of the Anasca.

Division 2. Malacostega.

Levinsen's first Division of the Anasca is here retained, but with the exclusion of the Aeteidae, as indicated above, and of the Scrupocellariidae, Farciminariidae, Bicellariellidae and Cribrilinidae. The Division is characterised by retaining the original frontal membrane in its primitive form and by having the operculum incompletely differentiated from this membrane.

1. The Scruparidae show some resemblances to the Aeteidae, but typical ovicells have made their appearance (*e.g.*, in *Scruparia*). I place them at the commencement of the Malacostega; but it is not impossible that, as implied by Levinsen (1909, p. 95), their apparent simplicity is secondary and that they have been derived, by reduction, from the Bicellariellidae.

2. The Membraniporidae are the central group of the Anasca, but they have evolved along many lines, in some cases leading to other Families. As here used, this group

is to be regarded as a Super-Family, which further study is likely to divide into a series of Families. They are in the main encrusting forms, in which the opesia is either co-extensive with the original aperture, or is more or less invaded by a calcareous cryptocyst, which develops beneath the frontal membrane. Ovicells and avicularia have appeared in some genera, and in a moderate number of cases the avicularia are of the primitive "vicarious" type, replacing ordinary zooecia. The avicularian rostrum and mandible have been differentiated as two independent series, respectively rounded and acute at the distal end.

In the Membraniporidae, as in other Families, it is necessary to take into consideration the question whether simplicity in structure is primitive or results from the loss, by reduction, of parts previously present. Some of the genera (*e. g.*, *Electra*) are apparently primitive. There is here no indication of avicularia, ovicells or pore-chambers, and in some cases the larva is known to be of the *Cyphonautes*-type. Reasons for regarding this as a primitive character are given below, in the systematic account of the Membraniporidae. In some other genera or species, the absence of avicularia or ovicells is probably due to reduction.

The archaic nature of certain Membraniporidae is indicated by the occurrence, in many Cheilostomes of other Families, of an ancestrula of a definite type, known as the *Tata*-form (see HARMER, 1902, p. 321). Its opesia is surrounded by a circlet of spines, which do not necessarily occur in the blastozooids, and these spines are comparable with the marginal and oral spines of many Membraniporidae.

3. The Flustridae resemble certain Membraniporidae in their large opesia, at most reduced by a slight development of the cryptocyst. The zoarium is nearly always free, frondose and not much calcified. The avicularia are vicarious, either rounded or acute, and the ovicells are entozooecial. This type of ovicell seems to be on the ascending line of evolution and to have preceded the hyperstomial ovicell; and in this case the Flustridae must be supposed to have branched off from early representatives of the Membraniporidae. In some of the higher Families hyperstomial ovicells seem to have reverted to the entozooecial type by reduction.

4. The Onychocellidae are characterised by possessing large vicarious avicularia of a peculiar and specialised type, with a unilateral or bilateral development of a thin expansion of the mandible. The cryptocyst is largely developed, marginal and oral spines have disappeared, and the ovicells are entozooecial and inconspicuous. The Family appears to have been evolved from early Membraniporine forms with a well developed cryptocyst and with avicularia of the primitive vicarious type.

5. The Lunulariidae have, in most cases, assumed a discoidal form, the zoarium being then unattached in the adult condition. In a few cases the zoarium is typically encrusting. The heterozooecia are specially conspicuous and have become vibracula with very long "setae". Ovicells are wanting or, apparently, in some cases entozooecial. The ancestors of this Family may have been related to those of the Onychocellidae.

Division 3. COELOSTEGA.

I use this form in preference to LEVINSEN's Coilostega. The margins of the zooecia are raised and surround an aperture which is larger than the opesia, owing to the development of

a cryptocyst, frequently with a descending portion which unites near its distal end with the vertical or basal walls. Many of them possess a "median process", at the distal end of the horizontal cryptocyst, forming the inner margins of two laterial opesiules, through which the depressor muscles pass to their insertion in the frontal membrane. Marginal and oral spines are typically wanting.

1. The Steganoporellidae were probably evolved from a very primitive Membraniporine ancestor, since their avicularia are, with one exception, modified zooecia still containing a polypide, and have differentiated mandibles more complicated than the opercula of the ordinary zooecia. Two types of these modified zooecia occur, but not both in the same species; representing respectively, on my view, the rounded and acute avicularia of other Families. The median process usually has a deep frontal depression, and a conspicuous opesiule is found on each side of it. Its basal surface assists in the formation of a peculiar "polypide-tube", through which the tentacles pass during their protrusion. Owing to the union of the descending cryptocyst with the vertical or basal walls, the zooecium becomes "dithalamic", the proximal and distal chambers communicating through the polypide-tube. Ovicells are wanting and had probably not been evolved in the ancestors of this Family. The embryo develops in the body-cavity of the zooecium.

2. The Labioporellidae are also dithalamic, the descending cryptocyst joining the basal wall. Their opercula are much smaller and simpler than those of the Steganoporellidae and do not articulate with the calcareous parts as in that Family. Avicularia are definitely differentiated and of the rounded type, but they have lost their polypides. Ovicells seem to be wanting.

3. The Thalamoporellidae are unique among Cheilostomata in developing numerous, free, calcareous spicules in the body-cavity. The median process and the closed and asymmetrical opesiules are highly developed, and the opesia is much reduced and situated near the distal end. The avicularia are large and vicarious, either rounded or acute. The ovicells, when present, are of peculiar, bivalvular type, found also in the Alysidiidae, a Family not represented in the Siboga Collection, but also referable to the Coelostega.

4. The Microporidae resemble the Thalamoporellidae in the reduction and distal position of the opesia, but are not known to possess spicules. The cryptocyst is very extensively developed and occupies the entire frontal surface. Its descending portion is usually lost, but is represented in *Calpensia*. The operculum is typically semicircular and completely differentiated from the frontal membrane, filling an orifice of the same shape. The closed opesiules are generally small and may be very inconspicuous. The ovicells, when present, appear to be entozooecial, and adventitious avicularia may be found.

5. The Selenariidae resemble the Lunulariidae (Malacostega) in their free, discoidal habit and in having highly differentiated vibracula, which are scattered irregularly in the colony and have a complicated frontal wall, not of uniform character throughout the Family. The opesia is typically Microporine, but is occasionally Membraniporine, perhaps by reduction.

6. The Poricellariidae are a small and peculiar Family, apparently derivable from Microporine ancestors. The zoarium is composed of delicate, free branches; the zooecia, in few rows, opening on the frontal and lateral surfaces. The cryptocyst and the orifice are as in *Micropora*, the cryptocyst being deeply depressed and perforated by a single, elongated opesiule. Acute avicularia occur, but ovicells are unknown.

7. The Chlidoniidae are typically composed of delicate, free, jointed branches, but are rarely repent. The cryptocyst is either highly developed, reaching the proximal border of the orifice, or is reduced to a vestige. Large vicarious avicularia, provided with polypides, are found in *Crepis decussata*, which I refer to this Family, but are otherwise unknown. Ovicells are wanting. The taxonomic position is obscure, but the vicarious avicularia of *C. decussata* and the absence of ovicells seem to point to their derivation from an early type of the Coelostega.

Division 4. Pseudostega.

As originally constituted by Levinsen, this Division consists of the Cellulariidae (Cellariidae of this Report) and the Membranicellariidae, a Family proposed by Levinsen in 1902 (p. 22) for *Melicerita dubia* Busk (1884, Chall., p. 97). Its most important character is the ovicell, which opens to the exterior by an independent orifice, on the distal side of the zooecial orifice. According to my own observations, the same character is found in the Aspidostomatidae, which Levinsen placed in the Coelostega. The cryptocyst is large and extends round the distal border of the orifice. The opercula and mandibles are bilaminar.

1. The Aspidostomatidae are encrusting or erect and unjointed. The cryptocyst is prolonged distally into a median process resembling that of the Steganoporellidae, and has a longitudinal ridge on either side of the opesia, the two ridges passing into one another in a curve round the distal margin of the orifice. The avicularia may be vicarious or, apparently, adventitious.

2. The Cellariidae are typically erect and jointed, occasionally unjointed. The orifice is often far removed from the distal end of the zooecium and is sometimes found almost at its middle. The zooecia are outlined by ridges, their relations being often masked by the overgrowth of the alternate zooecia over the proximal ends of their successors. The avicularia are vicarious, and the ovicells are generally inconspicuous and immersed in the branch.

Division 5. Cellularina.

This large and important Division consist of species which are usually ramified, with free unilaminar branches, typically narrow and frequently biserial. The Cellularina have probably been evolved from primitive unilaminar, encrusting, Membraniporine ancestors, and have typically become free except at the base of attachment, the unilaminar sheet having become subdivided into branches by radial slits, open distally. The heterozooecia, which are of the acute type, are highly differentiated and may be either avicularia or vibracula, or both. The ovicells are hyperstomial, sometimes secondarily entozooecial, or disappearing completely, by reduction.

1. The Scrupocellariidae are the central group of the Cellularina. The heterozooecia are both avicularia and vibracula, the avicularia not jointed at the base and occurring both frontally and marginally; and the vibracula basally placed. Vibracula are seldom wanting in the genera which possess them, but the avicularia are not infrequently reduced in number. One of the marginal spines, the scutum, is frequently more or less enlarged and overarches the frontal membrane, but in all genera this spine may disappear by reduction.

2. The Euoplozoidae unite certain characters possessed by the Scrupocellariidae, the Epistomiidae and the Bicellariellidae. They resemble the Epistomiidae in having each zooecium divided into three sections by two joints and in the dimorphism of their avicularia. They differ from them in their unilaminar habit, entirely different from the complicated arrangement of the zooecia found in that Family, and in possessing large hyperstomial ovicells. Their frontal avicularia resemble the pedunculate avicularia of the Bicellariellidae, although apparently unjointed at the base, and the remarkable flexor muscles of their zooecia are like those of *Kinetoskias*, belonging to that Family. In habit and in having both frontal and marginal avicularia they resemble the Scrupocellariidae, to which they are specially related by their sessile marginal avicularia, which do not occur in the Bicellariellidae.

3. The Epistomiidae have paired zooecia, divided into three sections as in the Euoplozoidae, but the internodes have a complicated structure, differing from the simple unilaminar arrangement found in that Family. Vibracula are wanting and the avicularia may be sessile and unjointed or pedunculate and jointed at the base. Ovicells appear to be wanting.

4. The Farciminariidae commonly possess large entozooecial ovicells, and have for this reason been placed by most authors in the neighbourhood of the Flustridae (Malacostega). Their avicularia, on the other hand, have advanced beyond the primitive vicarious type characteristic of the Flustridae, and seem to justify the inclusion of this Family in the Cellularina. If this view can be accepted, their ovicells may be supposed to have reverted from the hyperstomial condition, or more probably to have remained in an arrested stage of development, not differing essentially from the Flustrine ovicell shown in text-fig. 1 A. (p. 202). *Farciminellum* (Pl. XVIII, fig. 10) shows an extreme stage of reduction of the ovicell, and a similar arrested development is found, among the Bicellariellidae, in certain species of *Bugula* (Pl. XXX, figs 15, 16, 8). As here understood, the Farciminariidae are mostly delicate, abyssal forms, attached to the ooze by a tuft of basal rootlets and of Cellariiform, unilaminar or bilaminar habit, with branches which are rarely much expanded. Avicularia are present on practically all the zooecia in certain species, but are reduced in number or have completely disappeared in others.

5. The Bicellariellidae are the most highly evolved Family, in which the avicularia are (except in *Himantozoum*) all pedunculate and jointed at the base, though occasionally wanting, by reduction. Vibracula are absent. The zoarium is typically much ramified, with biserial (sometimes pluriserial) zooecia, but *Beania* is more or less of the encrusting type. The ovicells are generally very prominent but may be reduced to vestiges, especially in a group of species of *Bugula* characterised by a particular type of bifurcation ("Type 3"). The Bicellariellidae include some of the most remarkable abyssal species found by the Siboga.

Division 6. Cribrimorpha.

The Cribrilinidae are distinguished by the growth, in ontogeny, of costae, modified marginal spines which overarch the opesia from its lateral and proximal sides and generally unite or fuse in the middle line. The primitively slit-like lacunae between the costae usually become subdivided into a row of pores in each intercostal space. The hypostegia, or cavity between the frontal shield and the frontal membrane, corresponds with the compensation-sac

of the Ascophora, from which it is hardly to be distinguished, in some cases, except by its mode of development. The costal area is occasionally greatly reduced, at the expense of the gymnocyst, which then constitutes almost the entire frontal wall. The hypostegia is not correspondingly reduced, but underlies the gymnocyst as well as the costal area. Its relations are then identical with those of the compensation-sac of Ascophora, some at least of which have probably evolved from Cribrimorph ancestors, which were themselves derived from Membraniporine forms.

D. Descriptions of Species.

Division 1. Inovicellata.

Inovicellata Jullien, 1888, CH, p. 8.

Fam. Aeteidae.

Aeteidae Smitt, 1867, KVAF, XXIV, p. 279.
Aeteidae Hincks, 1880, BMP, p. 1.
Aeteidae Busk, 1884, Chall., p. 1.
Aeteidae Jullien, 1888, CH, p. 24.
Aeteidae Levinsen, 1909, MSSB, p. 92.
Aeteidae Canu and Bassler, 1920, USNMB, 106, p. 177.

"Zooecia tubular, with a subterminal membranous area; partly erect and free, partly decumbent and adherent; uniserial" (Busk, 1884). Avicularia, vibracula, and ovicells of the ordinary Cheilostome type wanting.

The members of this very isolated Family differ from other Cheilostomes in having the distal part of the zooecium prolonged into an elongated, free, cylindrical portion, to which Jullien (1888, p. 23) gave the name "péristomie". As pointed out by Waters (1897, JLS, XXVI, p. 5), the "peristome" of *Aetea* is not comparable with the part usually so named, since it constitutes the prolonged distal portion of the zooecium (as stated by Smitt, 1867, p. 295) and bears the operculum at or near its extremity, while in other Cheilostomes the "peristome" is a tubular prolongation of the zooecium beyond the orifice.

Although parts of the colony may become entirely free from the substratum, as in certain forms of *Aetea truncata*, the species of this genus typically form uniserial growths, adnate basally. Busk (1884, p. 1) grouped the Aeteidae with the Eucrateidae and Chlidoniidae in a division Stolonata; but the "stolon" of the Aeteidae implied by this association is the sum of the proximal ends of the zooecia, and is not completely comparable with the similarly named portion in the Stolonifera among the Ctenostomata; — a tubular thread giving off the zooecia but distinct from them.

According to the observations of Smitt (1865, KVAF, XXII, pp. 12, 14), the everted tentacle-sheath of *Aetea* is surrounded at its base by a circlet of small teeth (see his Pl. III, figs 4—8) which he compared with the "collar" of Ctenostomata. In a later work (1867, p. 279)

he included this collar in his diagnosis of the Family; and in both places he expressed the opinion that it indicates an affinity to the Ctenostomata. Waters (1879, AMNH, 5, III, p. 114) and Hincks (1880, pp. 1, 6) confirmed the existence of the collar and followed Smitt in placing *Aetea* in the Cheilostomata. Ulrich and Bassler (1904, SMCQ, XLV, p. 264 n.) state, on the other hand, that the Ctenostomatous affinities of *Aetea* predominate decidedly over the Cheilostomatous affinities.

It is well known that *Aetea* has an operculum moved by muscles similar to those of ordinary Cheilostomata, to which group it would thus belong by definition. It does not seem to have been generally noticed that Gosse (1853, NRDC), who observed the collar of *Aetea* (Pl. VII, fig. 9) before this was done by Smitt, described and figured (p. 134, Pl. VI, fig. 4) a precisely similar structure in *Eucratea chelata* auctt. [1]), a species whose position in the Cheilostomata is not disputed. Even if the presence of a collar in the two groups is not regarded as the result of convergence in evolution, it does not necessarily follow that the Ctenostomata were the ancestors of the Cheilostomata. The characters of the earliest known fossil Cheilostomes lend little support to the suggestion of a Ctenostome ancestry. The opposite view may be the correct one, and the Stoloniferous Ctenostomes at least may have been derived from an *Aetea*-like ancestor, with the loss of the operculum and of calcification in the body-wall. The similarity of the "ovicells" of *Aetea* to the ovisacs of *Nolella*, as pointed out below, appears to strengthen this conclusion.

Jullien (1888, pp. 8, 23) separated the Aeteidae from the remainder of the Cheilostomata as a special Tribe, Inovicellata, characterised by not possessing ovicells. Waters (1897, JLS, XXVI, p. 5, Pl. I, figs 1—3) has more recently described "ovicells" in Mediterranean examples of "*Ae. anguina*, forma *recta*"; and he considers that this discovery precludes the acceptance of Jullien's Tribe. The ovicell in question is a small, thin-walled vesicle, situated at the extreme distal end, on the side opposite to that which bears the orifice. In a later paper (1913, BEA, p. 463, Pl. LXIV, fig. 1) he described ovicells of the same type in *Ae. anguina* from British East Africa. Miss Robertson (1905, NCNA, p. 245, Pl. IV, fig. 4) found similar ovicells, in Californian specimens which she referred to the same species, but stated that they are present on the proximal side of the operculum, and on the same side of the zooecium. Osburn (1912, BBF, XXX, p. 220, Pl. XXI, fig. 14a) gives an account of ovicells, resembling those described by Waters in form and position, in the same species from the eastern coast of the United States. Levinsen (1909, MSSB, p. 93) pointed out that the "ovicell" appears not to be calcareous and is therefore not a true ovicell, a conclusion supported by its "very unusual position on the basal side of the zooecium". He suggested that the structure is merely a shell-membrane surrounding the egg.

The ovicells of the *Aeteidae* correspond neither in structure nor in position with those of other Cheilostomes, but on the other hand they resemble the ovisacs described by Prouho in the Ctenostomatous genus *Nolella* (see Part I of my Report, 1915, p. 56, Pl. IV, fig. 17). In view of this fact, the occurrence of a collar in *Aetea* and *Scruparia*, as noted above, acquires additional significance.

1) I have elsewhere (1923, JLS, XXXV, pp. 307, 316) expressed the opinion that this species is the genotype of *Scruparia* Oken and that this genus should be accepted.

Aetea Lamx.

Aetea Lamouroux, 1812, MPC, p. 184; — 1816, PCF, p. 150.
Falcaria (*pars*) Oken, 1815, LN, p. 91 (*nec Falcaria* Haworth, 1809, Lepidopt. Britann., p. 152).
Anguinaire Lamarck, 1812, ECZ, p. 24.
Anguinaria Lamarck 1816, ASV, p. 142.
Aeteopsis and *Aetiopsis* Boeck, 1862, FVSC (1861), p. 49.
Aetea and *Cercaripora* Fischer, 1866, NAMHN, Mém., II, p. 312.
Monotypical. Genotype, *Sertularia anguina* L., 1758.

Characters those of the Family. The anatomy has been described by various authors; and, in addition to those already quoted, reference may be made to the accounts of Lister (1834, PTRS, p. 385, Pl. XII, fig. 4), who figured a zooecium with the tentacles protruded, and Busk (1849, TMS, II, p. 123). Regeneration of the distal part of the zooecium has been described by Busk (*t. cit.*, p. 126) and by Smitt (1865, KVAF, XXII, p. 29). The genus is said to occur from the Eocene onwards (Canu and Bassler, 1920 (USNMB, 106, p. 178).

1. *Aetea anguina* (L.). (Pl. XIII, figs 3, 4).

Snake Coralline Ellis, 1755, NHC, p. 43 Pl. XXII, N° 11, c, C, D.
Sertularia anguina, L. 1758, SN, p. 816; — 1767, p. 1317.
Cellaria anguina Ell. and Sol., 1786, NHZ, p. 26.
Aetea anguina Lamouroux, 1812, MPC, p. 184; — 1816, PCF, p. 153, Pl. III, fig. 6.
Aetea anguina Busk, 1852, BMC, p. 31, Pl. XV, fig. 1 (*Anguinaria spatulate* on Plate).
Aetea anguina Hincks, 1880, BMP, p. 4, Pl. I, figs 4, 5.
Aetea anguina Busk, 1884, Chall., p. 2.
Aetea anguina Calvet, 1902, TIZM, 11, p. 8. Cette.
Aetea anguina Jullien and Calvet, 1903, BCH, p. 122. Azores.
Aetea anguina Thornely, 1905, PGM, p. 108. Gulf of Manaar.
Aetea anguina Osburn, 1912, BBF, XXX, p. 220, Pl. XXI, figs 14, 14*a*. U. S. America, E. coast.
Aetea anguina Sumner, Osburn and Cole, 1913, BBF, XXXI, Pt I, pp. 109, 110, Chart 29; — Pt II, p. 597.
Aetea anguina Waters, 1913, BEA, p. 463, Pl. LXIV, figs 1, 2. British E. Africa.
(?) *Aetea anguina* Robertson, 1905, NCNA, p. 244, Pl. IV, figs 1—4. California.
Aetea anguina, forma *spathulata* Smitt, 1867, KVAF, XXIV, p. 280, Pl. XVI, figs 2—4.
Anguinaria anguina de Blainville, 1834, MA, p. 467, Pl. LXXIX, figs 3—3*b*.
Anguinaria anguina Lister, 1834, PTRS, p. 385, Pl. XII. fig. 4.
Anguinaria spatulata Lamarck, 1816, ASV, p. 143.
Anguinaria spatulata Johnston, 1838, HBZ, p. 266, Pl. XXX, figs 7, 8; — 1847, HBZ, p. 290, Pl. L, figs 7, 8.
Anguinaria spatulata Busk, 1849, TMS, II, p. 123, Pl. XXVI, figs 1—7.
Anguinaria spatulata Gosse, 1853, NRDC, p. 142, Pl. VII, figs 8—16.
(?) *Aetea azorensis* Jullien and Calvet, 1903, BCH, p. 123, Pl. XVI, fig. 1.

380. E. Stat. 47. Bima, Sumbawa, N., 55 M. On a Hydroid.
341. B. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
491. B. Stat. 145. E. of S. point of Halmaheira (Djilolo), 827 M.
396. T. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
515. B. Stat. 173. Off E. coast of Ceram, 567 M.
347. F. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
296. G. } Stat. 273. Jedan, Aru Is., 13 M.
298. E. }

Cambridge, Mus. Zool.: —

Torres Straits, 124. A. C. HADDON, Reg. Feb. 24, 1898.
BM Japan, off Tokyo, 7. B. A. OWSTON, Reg. June 23, 1902.

Zooecia with a long, attached portion, at first delicate and of uniform diameter, then gradually dilating and passing at right angles into the free distal peristome, which is straight and then curved. Frontal membrane on the side facing the adherent part, expanding at its middle, the operculum terminal. Peristome at first with numerous annulations, its distal portion and the dilated part of the adherent region with numerous punctuations. Each zooecium normally gives off a distal bud from the end of the adherent portion, which may produce an occasional lateral bud. The septum dividing the lateral bud from its parent is convex towards the body-cavity of the older individual.

This species has an extremely wide Geographical Distribution, extending, according to WATERS (1913, p. 464), from the Arctic Ocean through the Atlantic and Mediterranean to Tristan da Cunha, South Africa, Zanzibar, British East Africa and the Gulf of Manaar, and reaching Australia and New Zealand; occurring also, in the fossil condition, in the upper Tertiaries of Italy, in the Helvetian of Egypt, and (CANU and BASSLER, 1917, USNMB, 96, p. 22), with *Ae. truncata*, in the American Eocene. BUSK (1852) stated that it occurs in the Antarctic Ocean; and DUERDEN (1896, JIJ, II, p. 270) has recorded it from Jamaica. *Ae. recta* Hincks has sometimes been regarded as a form of *Ae. anguina* (SMITT, 1867, p. 281; WATERS, 1897, JLS, XXVI, p. 5), but this view is disputed by CALVET (1902, TIZM, 11, p. 10) and seems to be improbable.

In European localities *Ae. anguina* is usually found in shallow and even in littoral waters. Although most of the Siboga records are from similar depths, it is remarkable that two of the specimens (491. B, 515. B) are from 567 to 827 M. The figured specimens are from the considerable depth of 827 M.; but I cannot find any characters by which they can be distinguished from shallow water specimens, either from the same district or from Europe.

The retracted alimentary canal and the retractor muscles extend into the adherent, proximal part of the zooecium, and the canal is not folded as in most Cheilostomes with a shorter zooecium. A typical series of delicate parietal muscles connect the calcified part of the distal region with the frontal membrane, on each side.

The nature of the markings on the calcareous parts is not clear. LEVINSEN (1909, MSSB, p. 92) regarded both the annulations and the punctuations as pores; while WATERS (1906, AMNH, 7, XVII, p. 12) considers them to be respectively ridges and protuberances; and, so far as I can make out, this opinion is correct. KLUGE shares this opinion, and he has described an allied species, from Cape Colony (1914, BDSE, p. 604), as *Ae. annulata*, distinguishing it from *Ae. anguina* mainly by the annulated character of its creeping portion, as well as of the erect portion.

The number of tentacles is usually said to be about 12 in *Ae. anguina*, though SMITT (1867, p. 297) stated that they may be as many as 16. I have no observations on this subject; nor can I give information with regard to the collar or the ovicells, in either this or the following species. The material available consists in all cases of a small number of zooecia. The species is inconspicuous, and is probably much commoner in Malay waters than would appear from the few records given.

2. *Aetea truncata* (Landsb.). (Pl. XIII, figs 5—7).

Anguinaria truncata Landsborough, 1852, HBZ, p. 288, Pl. XVI, figs 57, 57*.
Aetea truncata Smitt, 1863, UUA, p. 19; — 1865, KVAF, XXII, p. 11, Pl. II, figs 5—14, Pl. III, figs 1—8; — 1867, KVAF, XXIV, p. 279, Pl. XVI, fig. 1.
Aetea truncata Hincks, 1880, BMP, p. 8, Pl. I, figs 8—12, Pl. II, fig. 3; — 1886, AMNH, 5, XVII, p. 254.
Aetea truncata Kirkpatrick, 1890, AMNH, 6, V, p. 16. China Sea.
Aetea truncata Levinsen, 1894, ZD, p. 40, Pl. I, figs 1, 2, Denmark.
Aetea truncata Waters, 1897, JLS, XXVI, p. 5. Naples, Rapallo; — 1913, BEA, p. 465, Pl. LXIV, fig. 3. Zanzibar.
Aetea truncata Jullien and Calvet, 1903, BCH, p. 32. Cape Verde Is., Azores.
Aetea truncata Robertson, 1905, NCNA, p. 246, Pl. IV, figs 5, 6. California; — 1921, BBB, p. 35. Ceylon.
Aetea truncata Osburn, 1914, CIW, 182, p. 186. Tortugas Is Florida.
Aetea truncata Kluge, 1914, BDSE, p. 603. Cape Verde Is.
(?) *Aetea argillacea* Smitt, 1865, KVAF, XXII, p. 29, Pl. IV, figs 17, 18.
(?) *Aetiopsis elongata* Boeck, 1862, FVSC (1861), p. 49.
Cercaripora truncata Fischer, NAMHN, Mém., II, 1866, p. 312.

Aetea longicollis Jullien and Calvet (1903, BCH, p. 32, Pl. II, fig. 7) seems to be nearly allied to this species.

20. O.
319. B. } Stat. 50. Badjo Bay, W. Flores, 0—40 M. On 319. A, *Scrupocellaria ferox*, etc.
31. G. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M. On 31. F, *Cellaria punctata*.
487. E. Stat. 129. Karkaralong Group, S. of Mindanao, 0—31 M.
101. E. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M. On sea-weed.
117. E.
139. B. } Stat. 164. W. of N. end of New Guinea, 32 M. On 139. A, *Scrupocellaria diadema*, etc.
562. B.
359. B. Stat. 240. Banda, Banda Sea, 0—45 M.
425. B. Stat. ? Banda Sea, on sea-weed.

Mainly repent, occasionally partially erect. Zooecia with a long, attached portion, the distal part more or less expanded, passing at an obtuse or right angle into the free portion, which is straight or very slightly curved. Aperture as in *Ae. anguina*, variable in length. Operculum on the truncate distal end. Proximal part of the peristome covered with numerous punctuations, like the rest of the zooecium. Distal buds as in *Ae. anguina*; the lateral buds more numerous, one or two given off, on each side, near the distal end of the attached portion.

This species has been recorded from the Arctic Ocean, the British and Scandinavian coasts, the Mediterranean, Madeira, Cape Verde Is, Tortugas Is (Florida), Zanzibar, China Sea and California; and, fossil, from the Helvetian of Egypt (Waters, 1913, p. 465) and the American Eocene. From the Siboga collection it is represented entirely from shallow water, not exceeding 45 M.

Ae. truncata is distinguished from *Ae. anguina* by the fact that the surface is everywhere punctuate, instead of being annulate in the proximal portion of the peristome, as well as by the straightness and truncated extremity of this part. The peristome varies much in length, and its truncated end is associated with the position of the operculum, which makes an angle with the frontal membrane (fig. 6), instead of being nearly in the same line with it, as in

Ae. anguina. The distal portion of the attached region may be but slightly dilated (fig. 7); but in 425.B, which was growing on sea-weed, this part is more dilated and is irregular in outline. One of the zooecia in 117. E. (fig. 5) bears two jointed, filiform appendages, which replace lateral zooecia. These structures have been described, in the same species, by other authors, as by Waters (1910, JLS, XXXI, p. 253). Similar appendages, but of different forms, are described by Waters, in the same paper, in two other species; — *Ae. crosslandi* (Pl. XXIV, fig. 8) and *Ae. lepadiformis* (fig. 9). The Siboga specimens, 117. E, were probably more or less erect, as in certain British specimens described by Hincks (1880, p. 9).

The position of the retracted polypide is represented in fig. 7. There is a well marked pharynx, separated from the oesophagus by an annular valve; and the alimentary canal is unbent during retraction. Parietal muscles occur as in *Ae. anguina*. The anatomy of this species has been described by Smitt (1863, p. 19; 1865, p. 11), who gives the number of tentacles as 12.

Division 2. Malacostega.

Malacostega (*pars*) Levinsen, 1902, p. 2; — 1909, pp. 88, 89, 91.

Fam. 1. Scrupariidae.

Scrupariadae (*pars*) Busk, 1852, BMC, p. 28.
Scrupariadae (*pars*) Fischer, 1866, NAMHN, Mém., II, p. 312.
Eucrateidae Hincks, 1880, BMP, p. 10.

I have previously pointed out (1923, JLS, XXXV, pp. 307, 310, 316) that the synonymy of this Family is in a very confused state; and the conclusions at which I arrived were as follows:

Eucratea Lamx., 1812. Genotype, *Sertularia loricata* L. (*Gemellaria*, auctt.).
Scruparia Oken, 1815. Genotype, *Sertularia chelata* L. (*Eucratea*, auctt.).
Gemellaria auctt. = syn. of *Eucratea* Lamx.

The Scrupariidae are a Family of doubtful affinities, but I am inclined to place them among the more primitive Cheilostomes, mainly in view of certain resemblances between *Scruparia* and *Aetea*, as noted above (p. 193), under *Aetea*. The Family is characterised by the erect, frequently uniserial habit of its members, by the tendency of the zooecia to have a tubular form (perhaps a primitive feature), and by the correlated restriction of the opesia to a part of the frontal surface. The proximal ends of the zooecia are simple, not equitant as in most of the Bicellariellidae. Hyperstomial ovicells occur in some species, but there is no evidence that avicularia have been evolved in the Family as I understand it.

It is possible, on the other hand, that the Scrupariidae have acquired their apparent simplicity by loss, and that Levinsen (1909, MSSB, p. 98) was right in placing them in the Bicellariellidae. Some support for this idea is given by *Corynoporella tenuis* Hincks (1888, AMNH, s. 1, p. 215), which has much resemblance to the species described below, but has a *Bugula*-like avicularium articulated to one side of the opesia. *Corynoporella* is perhaps a synonym of *Bugulella* Verrill (1870, AJSA, 3, XVII, p. 472). *Bugulella clavata* Hincks (1887, JLS, XXI, p. 122), from the Mergui Archipelago, was described from sketches, after the loss of the specimen, and is said to have had a pair of articulated avicularia at the distal end of the zooecium.

Brettia Dyster.

Brettia Dyster, 1858, QJMS, VI, p. 260.
Brettia Hincks, 1880, BMP, p. 27.
Brettia Busk, 1884, Chall., p. 7.
Brettia Waters, 1900, JLS, XXVIII, p. 51; — 1904, BB, p. 26; — 1913, BEA, p. 465.
Brettia Levinsen, 1909, MSSB, pp. 98, 113.
Monotypical. Genotype, *B. pellucida* Dyster, 1858.

Brettia was introduced by Dyster for a single species with uniserial, elongate, narrow and tubular zooecia, each giving off two successors distally, and with a short distal opesia surrounded by small marginal spines. Nichols (1911, FISI, 1910, 1, p. 7) has described hyperstomial ovicells in a form referred by him to the type-species, under the name of var. *gracilis* [1]). Levinsen (1909) gave *Maplestonia* MacGill. (1885, PRSV, XXI, p. 92) as a possible synonym; but from an examination of *M. cirrata*, the type-species, I think this is unlikely to be correct.

1. *Brettia mollis* n. sp. (Pl. XXIII, figs 1, 2).

619. B. Stat. 2. Madura Strait, 56 M. One colony.

Zoarium extremely delicate, apparently devoid of calcification, reaching a length of 17 mm., attached by a stalk composed of parallel rootlets, which diverge into an attaching tuft at the base. Branches completely uniserial, each zooecium giving off a pair of zooecia at its distal end, their proximal ends in contact. Zooecia elongate, with a long opesia, spineless, jointed close to the proximal end, which is thus segmented off as a small rounded chamber. Rootlets given off from the outer sides of these chambers.

The colony here described has collapsed, like a delicate Ctenostome, in Canada balsam, and my account of it is accordingly unsatisfactory. The parts of the rootlets which constitute the stalk have sufficiently resistent walls to have retained their cylindrical form, but those composing the basal tuft are wider and much collapsed. The zooecia vary greatly in length, most of them being extremely long and narrow, but towards the ends of the branches they are much shorter and more dilated distally. The polypides are relatively large, and the tentacles, many of which are protruded, are about 16. Rootlets are not developed at the ends of the branches, but many of the other zooecia produce them. They run down the basal side of the branch, closely applied to the zooecia. Neither ovicells nor avicularia have been found.

B. mollis appears to be related to *B. cornigera* Busk (1884, p. 7), but differs from it in being spineless. It seems to be distinct from *B. tropica* Waters (1913, BEA, p. 465), from British East Africa, recorded also by Miss Thornely (1916, POK, p. 159) from N. W. India.

Super-Fam. 2. Membraniporidae.

Preliminary considerations on the principles of their classification.

This group, characterised by the presence of a frontal membrane filling the aperture, and of an opesia, either co-extensive with that membrane or reduced by the development of a

1) This "variety" appears to belong to the Membraniporidae. See *Allantopora*, p. 225.

cryptocyst, as well as by being usually encrusting in habit, may be regarded as the central group of Cheilostomata, showing affinities in different directions to other Families. It is probably deserving of higher taxonomic rank than that of a Family, but in spite of attempts to subdivide it, by WATERS and others, the principles on which it should be arranged are still very uncertain. The Siboga collection includes a moderate number of its genera, mostly represented by only one or two species; but these are not sufficiently numerous to constitute a good point of departure for a critical re-arrangement of the group. The principal types were already well established in the Cretaceous, and a reference to the Plates of D'ORBIGNY (1851—1854, PFTC) will show that at this period there already existed forms without a definite cryptocyst or with that layer highly developed; with avicularia, vicarious or adventitious; and with or without hyperstomial ovicells. It is not surprising that the recent species of this ancient group should have to be distributed among a considerable number of genera, many of which have been introduced by NORMAN and others in recent years.

(I) *Cyphonautes*. — In considering the lines on which the Membraniporidae and other Cheilostomata have evolved, it appears to me important to take account of the occurrence of the *Cyphonautes* larva in certain species and to endeavour to obtain a clear idea of the structure of the ovicells in others. In respect of the larva I am to some extent in agreement with CANU and BASSLER (1920, USNMB, 106, p. 71), who state that "All the species which have the same larval form have the same lineage and belong to the same family". This statement goes too far, however, as the larva in question occurs in both Ctenostomata and Cheilostomata. In defining the Family Electrinidae (p. 76) as possessing a *Cyphonautes* larva, they again go beyond the evidence; and it is necessary to enter a protest against the use by these authors, here and in many other places in the same work, of diagnostic characters which have been established in one or two cases only and cannot possibly be proved to have been present in the fossil forms.

Although in an early paper (1888, AZEG, 2, V, p. 455) I committed myself to a different opinion, I must now express the belief, which is in accordance with that of KUPELWIESER [1]) and others, that the occurrence of *Cyphonautes* in species which may fairly be considered of primitive type is a fact of high morphological importance, indicating a larval form of archaic character. Among Cheilostomata, *Cyphonautes* is certainly known in species referable to *Electra* or an allied genus; and among Ctenostomata, in *Alcyonidium* and *Hypophorella*. In one or two other genera, as noticed below, the larva appears to be a modified *Cyphonautes*, which is no longer pelagic. These facts may imply that the encrusting Ctenostomes have been derived from Membraniporine Cheilostomes, a view which is not discordant with the evidence, brought forward by LEVINSEN (1909, MSSB, pp. 93, 107), WATERS (1925, AMNH, 9, XV, p. 344) and others, of resemblances between members of the two Orders. A diphyletic origin for the Ctenostomata is thus indicated if the view suggested above (pp. 187, 193) of the derivation of the Stoloniferous Ctenostomes from an *Aetea*-like ancestor is to be accepted.

It may further be noticed that ovicells are not found in any Cheilostome known to possess a *Cyphonautes* larva, or in which the occurrence of this larva is probable. It appears that these Cheilostomes represent a stage in evolution preceding the differentiation of ovicells,

1) KUPELWIESER, H., 1905, "Untersuchungen über den feineren Bau und die Metamorphose des Cyphonautes", Zoologica, Bd. XIX, Heft XLVII, p. 41.

and that they are in fact the natural starting point for the consideration of the Cheilostomata in general, with the exception perhaps of the aberrant Aeteidae and of the Scrupariidae. It does not follow, however, that all Cheilostomes without ovicells belong to this stage in evolution: and it seems quite certain that some of them, for instance *Himantozoum* (Bicellariellidae), have been derived from ancestors with well developed ovicells. The taxonomic position of a Cheilostome without ovicells must accordingly be scrutinised in connexion with the facts known with regard to other species to which it appears to be allied; but it may be noted that the increase in the amount of yolk in the egg is probably one of the causes which has led to the degeneration of the ovicell.

In 1893 Prouho published a most illuminating paper (AZEG, 2, X, p. 557) on the morphology of certain Polyzoa: showing that the *Cyphonautes* larva, which differs from others known in Ectoprocta in possessing a functional alimentary canal, is present in three species not nearly related to one another. These are *Alcyonidium albidum* and *Hypophorella expansa* (Ctenostomata) and *Electra pilosa* (Cheilostomata). In each case he showed that the eggs develop in the external water, first falling into the body-cavity and passing thence to the exterior through the "intertentacular organ", a flask-shaped body situated on the lophophore, between the two anal tentacles. This organ has been observed in certain other Polyzoa, as in *Nichtina telacea* [1], by Hincks (1880, BMP, p. lxxxix), who also noticed it in *Alcyonidium gelatinosum* and *A. mytili*. In *Alcyonidium* (pp. lxxxvi, xc) he observed the passage of innumerable spermatozoa, through the intertentacular organ, to the exterior.

It is only in one or two cases that a *Cyphonautes* can be certainly referred to an adult form. *C. compressus* Ehrb. is definitely known to be the larva of *Electra pilosa*, and Miss Robertson (1908, ICNA, pp. 271, 272) proved that a Californian larva which she named *C. occidentalis* belongs to *Membranipora villosa* Hincks (see below, under *Nichtina*). In other cases it is possible to make a plausible guess with regard to the relation between an adult form and its larva. Lohmann [2]) states that in its distribution *Cyphonautes* is closely associated with the coast-lines or with the localities abounding with the Gulf-weed, *Sargassum*. There is a strong presumption that *Nichtina tuberculata* (Bosc), which is so characteristically found on this Alga, is the adult of the larva, with the same distribution, to which he has given the name *C. sargassi*. One of the commonest Baltic Polyzoa is the species which was described by Smitt as *M. pilosa* forma *membranacea*, and more recently by Bidenkap [3]) as *M. mülleri*. Levander [4]), who stated that *Cyphonautes* is to be found in all the Oceans, has pointed out that a *Cyphonautes* larva occurs in the Gulf of Bothnia as far north as 63° 29′ N., which is precisely the northern limit of *M. mülleri*. It seems possible that the larva described, from the Baltic, by Lohmann [5]), as *C. balticus*, may belong to this species. Statements in literature that *Cyphonautes* has been found in *M. membranacea* refer principally, if not exclusively, to *M. mülleri*, and I have been unable to find definite evidence of its occurrence in the British species commonly known by that name.

1) = *Membranipora membranacea* auctt.

2) Lohmann, H., 1904, "Cyphonautes", Ergebn. Plankton-Exp., IV, p. 53.

3) Bidenkap, O., 1900, in Römer and Schaudinn, "Fauna Arctica", I, Lief. 3, p. 532. For Baltic Polyzoa see also Levander, K. M., 1888, ANG, LIV, I, p. 1.

4) Levander, K. M., 1914, "Cyphonautes", Bull. Trimestr. Int. Expl. Mer, Résumé Plankton, 3 Partie, p. 515.

5) Lohmann, H., 1911, Nord. Plankton, IX, 3, p. 38.

Lohmann (*op. cit.*, 1904) described eight named species of *Cyphonautes*, from the Atlantic region alone. Ramsay Wright [1]) recorded a *Cyphonautes*, stated to be from "*Membranipora* sp.", in Nova Scotia waters; and another was found in the Chilka Lake, E. coast of N. India, by Annandale [2]), who seems to have been inclined to refer it to *Conopeum reticulum* (= *M. lacroixii* auctt.). Ostroumoff [3]) stated that the same type of larva occurs in the life-history of two species from the Black Sea, *M. (Tendra) repiachowi* Ostr. [4]) and *M. denticulata* Busk, this determination being improbable, as Busk's species was described from Mazatlan, W. coast of Mexico. *Tendra zostericola* v. Nordm., the genotype of *Tendra*, which includes one of the species mentioned by Ostroumoff, does not possess a *Cyphonautes*, but it is noteworthy that its larva has a vestigial alimentary canal which is much more recognisable than that of most Ectoproct larvae. The same may be said of *Flustrella hispida*, a Ctenostome whose larva possesses a bivalve shell, as in *Cyphonautes*, but is of large size, with much yolk, and has a distinct, though vestigial alimentary canal [5]). *Pherusa tubulosa*, another Ctenostome, has a similar larva (Prouho, *op. cit.*, p. 565), resembling that of *Flustrella*.

The evidence derived from a consideration of *Cyphonautes* thus seems to show that *Electra*, *Nichtina* and their allies are specially primitive genera of Cheilostomata. The complete absence in them, not only of ovicells but also of avicularia, probably indicates that neither of these structures was present in their ancestors. Waters (1924, AMNH, 9, XIV, p. 599) has already stated his belief that these two genera are widely separated from other Membraniporidae.

(II) Ovicells. — Descriptions of the ovicells of Cheilostomata are to be found in every systematic account, but few authors have made a serious attempt to decide how far the different types are homologous structures. The best description which has been given appears to be that of Calvet (1900, TIZM, 8, pp. 56, 100, 259), who has published excellent figures of decalcified sagittal sections. Levinsen (1902, VMNFK, p. 11; — 1909, MSSB, p. 49, diagrammatic figures on Pl. XXIV, and elsewhere) specially discussed the ovicells, but with insufficient consideration of the living tissues. His results are in general agreement with those of Calvet, and, I think, justify the addition of the calcareous parts which I have made to the figures of that author reproduced in text-fig. 1.

The commonest type of Cheilostome ovicell is the "hyperstomial" form (*B.*), situated on the distal side of the orifice, and composed principally of a helmet-like structure, usually projecting considerably above the level of the frontal surfaces of the zoocia. The helmet is composed of two layers, usually both calcareous, and respectively the ectooecium (*Ect*) and the entooecium (*Ent*). The cavity between the two layers contains cellular elements, in the young stage, although they have disappeared when the ovicell has become fully formed; and it is morphologically an internal cavity of the body. The brood-space in which the embryo (*E*) develops is morphologically external. The ovicell is completed by the formation of a more proximally situated membranous vesicle (*M.V.*), which is developed as an outgrowth of the

1) Wright, R. Ramsay, 1907, "Further Contributions to Canadian Biology", 39 Ann. Rep. Mar. and Fish., Fisheries Branch, Ottawa, p. 14, Pl. V, fig. 12.
2) Annandale, N., 1915, Mem. Ind. Mus., V, p. 124.
3) Ostroumoff, A., 1885, Zool. Anz., VIII, p. 219.
4) Ostroumoff, A., 1886, Trud. Obschtsch. Estest. (Kazan), XVI, Pt 2, p. 20.
5) Page, (Mrs) R. M., 1906, QJMS, L, p. 435.

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distal body-wall of the proximal or fertile zooecium, and is traversed by muscles, which regulate the final escape of the embryo.

The entozooecial ovicell (*A.*) is of simpler type, particularly in the absence of a calcified ectooecium, which is represented, however, by a part of the frontal membrane (*Ect*) of the distal zooecium. I believe this kind of ovicell to have preceded the hyperstomial ovicell in evolution, and to have given rise to it. The brood-space is morphologically external, as in the hyperstomial ovicell, and it may be regarded as a cavity between the zooecia of a longitudinal row (Cf. CALVET, *t. cit.*, p. 271). LEVINSEN (1909, p. 56) regarded the calcified entooecium as a bent portion of the terminal wall of the fertile zooecium, but I think that this conception requires modification, if account is taken of the disposition of the cellular parts of the ovicell. It appears to me that the terminal wall, which normally separates the body-cavities of two adjacent zooecia, is reduced by the development of an ovicell and is represented solely by the vertical part shown (in *A.*)

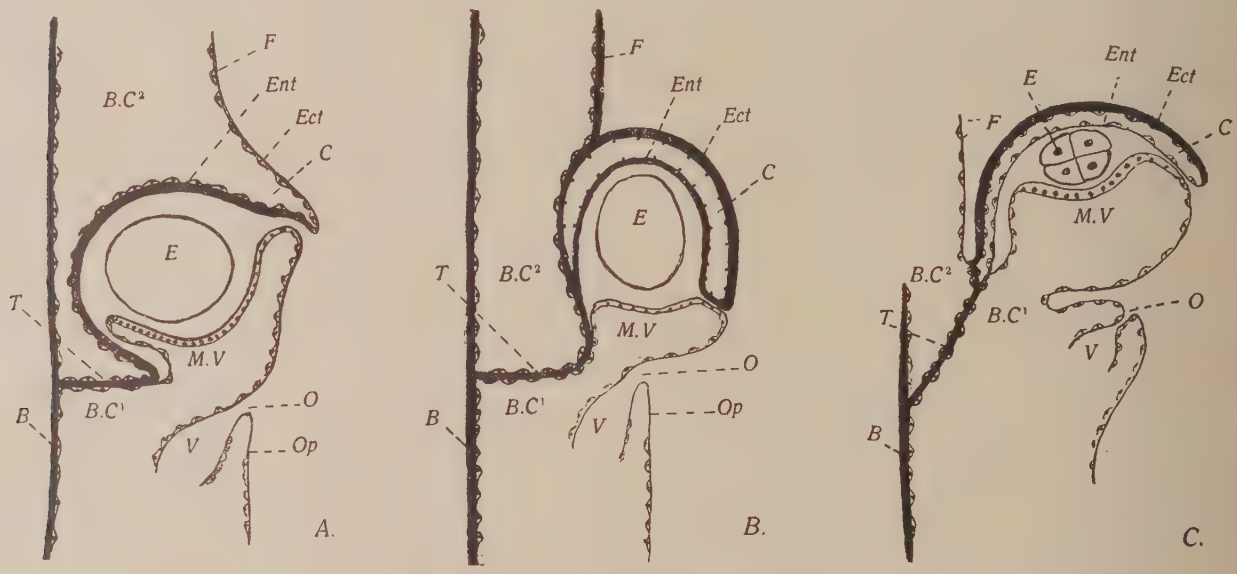

Fig. 1. — Diagrammatic sagittal sections of ovicells. The calcareous parts are indicated by thick lines.
After CALVET, "Contr. Hist. Nat. Bryozoaires Ectoproctes marins", Trav. Inst. Zool. Univ. Montpellier, N. S., Mém. 8, pp. 263, 262, 57).
A., *Flustra securifrons* (entozooecial); *B.*, *Amphiblestrum flemingii* (hyperstomial); *C.*, *Bugula sabatieri* (hyperstomial).
B, basal wall; *B.C*¹, body-cavity of proximal zooecium; *B.C*², body-cavity of distal zooecium; *C*, cavity between ectooecium and entooecium; *E*, embryo; *Ect*, ectooecium; *Ent*, entooecium; *F*, frontal membrane of distal zooecium; *MV*, membranous vesicle of ovicell; *O*, orifice; *Op*, operculum; *T*, terminal wall; *V*, vestibule.

in connexion with the basal wall. The entooecium, of which one surface is in contact with an external cavity, is to be regarded as a depression of the frontal surface; and it is important to notice that it is formed in this way during its ontogeny (LEVINSEN, 1909, MSSB, p. 57, Pl. XIX, figs 8*b*—*f*). On this view it is a calcified part of the frontal membrane of the distal zooecium, and at its frontal edge it passes continuously into the remaining, uncalcified, part of the frontal wall. The membranous vesicle, on the other hand, is an outgrowth of the distal wall of the proximal or fertile zooecium. In some ovicells of this type the entooecium and the unmodified frontal membrane of the distal zooecium are reflected further over the membranous vesicle than in fig. 1, *A*. The calcified entooecium is then seen, in frontal view, through the uncalcified frontal membrane of the distal zooecium, in which it appears to be "immersed", as usually described.

Returning to the hyperstomial ovicell (*B*) it is clear that its entooecium (*Ent*) corresponds with that of the entozooecial ovicell. The part of the ectooecium (*Ect*) which has a free external surface is homologous with that marked *Ect* in text-fig. 1, *A*., but it has arranged itself concentrically with the inner layer, and has become calcified. From the point where it joins the frontal membrane (*F*) of the distal zooecium to the point where it meets the entooecium, more proximally, I think it should be regarded as a cryptocyst belonging to the distal zooecium; and this view is definitely indicated by LEVINSEN in his Pl. XXIV, figs. 12, 17.

In the Bicellariellidae (text-fig. 1, *C*.) the ovicell has become more individualised, though still belonging to the hyperstomial type. Its outer layer has a free external surface throughout, and it may thus be regarded as a derivative of the frontal membrane of the distal zooecium. The cryptocyst is represented merely by the very short calcareous wall which separates the body-cavity (*B.C*^{2}) of the distal zooecium from the cavity between the ectooecium and the entooecium. The latter is here thin, and may be uncalcified. If these conclusions are correct, there is no difficulty in considering the two types of ovicell as strictly homologous structures. In both cases the brood-space is a cavity between the distal wall of the proximal zooecium, represented by part of the membranous vesicle, and the frontal wall of the distal zooecium.

The manner in which the egg, developed in the body-cavity of the proximal zooecium, reaches the brood-space of the ovicell has long been in doubt, but the view which has found most favour is that it passes through the wall of the membranous vesicle. This question seems to have been satisfactorily solved, in a different way, by GERWERZHAGEN (1913, UB), who in an important and little known paper has recorded his observations made on living specimens of *Bugula avicularia*. He states that the egg passes, in the body-cavity, to the base of the lophophore, where it is definitely laid through a pore situated in the same position as that of the intertentacular organ described above (p. 200). With the assistance of the fertile polypide, it passes into the brood-space between the entooecium and the distal wall of the membranous vesicle; the position which it has long been known to occupy during its development. These observations may, I think, be definitely regarded as correct, and they throw a most important light on a problem which had been very difficult to solve.

It may be remarked that while the eggs which develop into *Cyphonautes* are always small, with little or no yolk, and are produced in considerable numbers (PROUHO, *op. cit.*, Pl. XXV, fig. 26 and others), the egg which develops in an ovicell is, with few exceptions, single, and usually has from the first a considerable amount of yolk [1]); its development resulting in the production of a larva with no functional alimentary canal and depending for its nutrition during its free life on its store of yolk. As compared with *Cyphonautes* these larvae must have a short free existence, and they are not found as typical constituents of the plankton. It is perhaps surprising that this striking difference has not expressed itself more definitely in the faculty possessed by a species of extending its range. As a matter of fact, ovicell-bearing Cheilostomes seem, on the whole, to be distributed as widely as species with a pelagic larva; but it must be remembered that, as pointed out above, *Cyphonautes* is restricted in its occurrence to coastal waters.

In discussing the intertentacular organ, several cases have been mentioned in which this

1) This is not the case in species of *Bugula*, where the ovum is small when it first passes into the brood-space. Its increase in size is presumably due to nutriment supplied through the membranous vesicle, which thus acts as a placenta.

structure occurs in a species which does not have a *Cyphonautes* larva. A well established case of this kind is recorded by PROUHO (*op. cit.*, p. 584) in *Alcyonidium duplex*, in which the eggs pass through it to the exterior. They do not become free in the water, but remain attached to the diaphragm separating the vestibule from the tentacle-sheath. In the extended condition of the polypide (his Pl. XXVII, fig. 46) they appear as a "collerette de perles" surrounding the base of the extended tentacle-sheath; while in the retracted condition (figs 54, 55) they lie in the vestibule, now withdrawn into the body-cavity. Cases of this kind support the conclusion that the reproductive pore observed by GERWERZHAGEN in *Bugula* represents the intertentacular organ; and, although its presence is merely inferred, I think it will probably be found, as a typical feature, in the fertile zooecia of most of the Cheilostomes. It may be noted that PROUHO described it as absent in the male polypides of *A. duplex* and as appearing later in the same zooecium, on the formation of a polypide bearing an ovary.

(III) *Avicularia*. — It is generally admitted that the "vicarious" avicularia, which occur in series with the ordinary zooecia, are more primitive than those of the "adventitious" type, which are found in various positions, as apparent appendages of the zooecia. Avicularia seem to be represented in their most primitive form in the Steganoporellidae, where (in *Steganoporella*) dismorphism of the zooecia is of practically constant occurrence (Cf. HARMER, 1900, QJMS, XLIII, p. 235). Those which I described as the "*B*" zooecia resemble the ordinary ("*A*") zooecia in possessing a polypide, and may even exceed them in size; but they differ from them in having hypertrophied opercula, which agree with typical avicularian mandibles in being moved by specially powerful muscles. I have previously suggested (1909, BAAS (1908), p. 724) that the "*B*" zooecia are to be regarded as incipient vicarious avicularia.

The species of *Steganoporella* are divided into two groups, in one of which the main sclerite of the mandible ("*B*" zooecia) is Λ-shaped, and in the other it is ∩-shaped. These two conditions appear to represent the commencing evolution of the acute and rounded mandibles, respectively, of the more highly evolved Cheilostomes. I accordingly attach great importance to this difference in the form of the mandibles.

Among the Cheilostomes of primitive type, vicarious avicularia are specially characteristic of the Onychocellidae and the Flustridae, and they occur in some of the Membraniporidae. Each species in which they are found has either one or the other of the two types, but never, so far as I am aware, both kinds. The study of the Membraniporidae leads to the conclusion that a species may still retain the faculty for evolving vicarious avicularia *de novo*, as is indicated by several of the species described below, in which avicularia of this type seem to be in an incipient stage of evolution, and may even occur (though not commonly) with adventitious avicularia. Another point which requires notice is that, as in the case of the ovicells, the complete absence of avicularia may imply either that the species in question belongs to a stage of evolution preceding the differentiation of these structures, or that it has secondarily lost them (see HARMER, 1923, JLS, XXXV, p. 329). *Electra* and *Nichtina* at least appear to me to belong to the former category.

(IV) *Pore-chambers*. — The classification of the Membraniporine forms is complicated by the occurrence, in certain genera, of the structures which were originally described by LEVINSEN

(1891, HT, p. 250) as pore-chambers ("Porekamre", singular). CANU and BASSLER (1920, USNMB, 106, p. 52) introduced the term "dietellae" [1]) for the same structures, having previously used this name in an earlier paper (1917, USNMB, 96, pp. 9 *et seq.*), apparently without an explanation of its significance. A full account of the structure of the pore-chambers is given in LEVINSEN's later memoir (1909, MSSB, p. 24), where it is shown that they are to be regarded as special modifications of the rosette-plates of other Cheilostomes. An ordinary rosette-plate is formed from part of the wall separating two contiguous zooecia. In the distal part of the zooecium, parts of the lateral walls project like blisters (rosette-plates) into the body-cavity, and are traversed by pores occupied by the living tissue which connects the two zooecia. Owing to the quincuncial arrangement usually found, the distal half of any zooecium is ordinarily opposite the proximal halves of its lateral neighbours. The proximal halves bear a series of single pores, larger than the others, and each corresponding with one of the blister-like structures of the distal halves of the adjacent zooecia (see LEVINSEN, 1909, Pl. XVII, fig. 10*c*). According to LEVINSEN, who gave good reasons for his conclusion, the pore-chamber is to be regarded as a rosette-plate with a basal wall of its own, which forms one of the sides of the triangular transverse section of the chamber. Cheilostomes thus provided show a more or less semicircular series of pore-chambers, usually in contact with one another, encircling the distal end of the zooecium, and most easily seen in marginal zooecia, where they are not concealed in frontal view. The "growth-chambers" described by WATERS (1924, AMNH, 9, XIV, p. 597) seem to be merely blister-like rosette-plates.

Among Membraniporine genera (see especially NORMAN, 1903, AMNH, 7, XI, pp. 584 *et seq.*) the occurrence of pore-chambers seems to be somewhat capricious; but, on the evidence at present available, they are usually found in genera with adventitious avicularia and ovicells, while they are absent in genera, such as *Electra* and *Nichtina* (without these structures), which there is reason to regard as archaic, on other grounds. The presence or absence of pore-chambers has not been demonstrated in a large proportion of the species; but, if the facts were more fully known, they might well form a valuable aid to the arrangement of Membraniporine genera. It seems probable, however, that pore-chambers, like avicularia and ovicells, may be secondarily lost; and that a natural genus which usually possesses them may include species in which they are wanting.

1. **Membranipora** de Blainville.

Membranipora de Blainville, 1830, DSN, p. 411; — 1834, MA, p. 447.

Introduced for six recent species, including *M. membranacea*, and five fossil species. Under *M. membranacea* de Blainville refers only to the *Flustra membranacea* of GMELIN's Edition of LINNAEUS (1791, p. 3830). Neither DE BLAINVILLE nor GMELIN refers to the fact that a *Flustra membranacea* had already been described by LINNAEUS in his 12th Edition (1767, p. 1301), with the Baltic as its locality. The British species known as *membranacea* (see p. 206) does not seem to occur in the Baltic, where the common species is *M. mülleri* Bidenkap (see p. 200); and it appears to be this Baltic form which should be identified with *F. membranacea* L. (1767).

1) Presumably from *diaeta*, a parlour to sup in, or chamber.

In stating that *M. membranacea* should be selected as the genotype of *Membranipora*, NORMAN (1903, AMNH, 7, XI, p. 585) had the British form in mind, as is clear from his description. He was accordingly referring to a species which was probably not that of LINNAEUS; but his selection was invalid, as CANU (1900, BSGF, 3, XXVIII, p. 380) had previously selected *M. membranacea* (also the British form, as shown by his figures) as the genotype of a new genus *Nichtina*. It must accordingly be concluded (1) that the British species usually known as *M. membranacea* is not entitled to that name, and that its correct trivial name is *telacea* (*Flustra telacea* Lamarck, 1816, ASV, p. 158); (2) that *Nichtina* may be accepted, with *F. telacea* as its genotype, unless any earlier selection can be shown to have been made. These conclusions have a certain convenience, since they leave *Membranipora* undetermined, and do not disturb the nomenclature of the very numerous species, recent and fossil, which can remain in it until their taxonomic position has been more definitely established. It has thus precisely the same value as *Membraniporina* Levinsen (1909, MSSB, p. 145), proposed for species of *Membranipora* auctt., which "cannot be referred to particular genera".

Electra Lamx.

Electra Lamouroux, 1816, PCF, p. 120.
Annulipora Gray, 1848, BMRA, pp. 107, 146. Genotype, selected by NORMAN (1894, AMNH, 6, XIII, p. 114), *Flustra pilosa* L.
Electrina D'Orbigny, 1851, PFTC, p. 188 (first of the two pages thus numbered). NORMAN (1894, *l. c.*) selected *E. lamellosa* as the genotype of *Electrina*, but both species indicated by D'ORBIGNY seem to be referable to *E. pilosa*. (Pre-occupied by *Electrina* Baird, 1850: See SHERBORN, 1922, IA, p. 2091.)
Reptelectrina D'Orbigny, 1852, PFTC, pp. 330, 333. Genotype, selected by NORMAN (1894, *l.c.*), *Flustra dentata* Ell. and Sol. (1786, p. 15), which is regarded as a synonym of *E. pilosa*.
"*M. pilosa* group" Waters, 1898, JLS, XXVI, pp. 660, 665.
Electra (*pars*) Canu and Bassler, 1920, USNMB, 106, p. 76.

Monotypical. Genotype, *Flustra verticillata* Ellis and Solander, 1786, NHZ, p. 15; usually considered to be a variety of *E. pilosa*. From the description recently given by WATERS (1924, AMNH, 9, XIV, p. 594, Pl. XVIII, figs 1—8), the ancestrula of *E. pilosa* is practically a shorter form of the ordinary zooecia. In view of the occurrence of a similar ancestrula in many other Cheilostomes, this affords a reason for believing that the zooecia of *Electra* are of a primitive type.

Usually encrusting. Zooecia more or less pear-shaped or rectangular, with proximal gymnocyst, which may be evanescent, distally with a frontal membrane covering an opesia of the same extent and surrounded by marginal spines, sometimes reduced to a single spine on the proximal side of the opesia. Cryptocyst wanting or barely indicated. Avicularia, ovicells and pore-chambers wanting. A *Cyphonautes* larva is known to occur in *E. pilosa*.

Tendra v. Nordmann (1840, in DEMIDOFF, Voy. Russ. Mérid., III, p. 651) and *Heterooecium* Hincks (1892, AMNH, 6, IX, p. 332) may be related genera. Both are characterized, in different ways, by the formation of a brood-chamber protected by cribriform bars. In *Heterooecium* these give rise to an ovicell which is probably not homologous with the hyperstomial ovicell of other Membraniporine forms. It should be noted that a *Cyphonautes* larva has been said to occur in

Tendra repiachowi Ostr. (see above, p. 201), and that the larva of *T. zostericola* v. Nordm. has a distinct, though vestigial, alimentary canal.

1. *Electra angulata* Lev. (Pl. XIII, fig. 11).

Electra angulata Levinsen, 1909, MSSB, pp. 149, 156, 160, Pl. XXII, fig. 4*a*. Siam, "on a ligneous core taken on the surface of the water".

257. A. Stat. 312. Saleh Bay, N. Sumbawa, 274 M. One colony, on rotten wood, attacked by Teredinidae and *Limnoria*.

Encrusting. Zooecia typically elongate, shallow, widest near the middle, separated by shallow grooves. Opesia elongate-oval, with a slight proximal cryptocyst. Marginal spines delicate, jointed at the base, varying in number, usually 6—8 pairs, overarching the frontal membrane. Mandible rather elongate, more chitinised than the frontal membrane. Gymnocyst moderate, bearing proximally a pair of strong, unjointed, vertical spines, or one only, commonly succeeded by a smaller median spine at the distal end of the gymnocyst.

The agreement with LEVINSEN's description is very close. It is noteworthy that, while his material and the Siboga specimen were both found on wood, LEVINSEN's specimen was floating at the surface while the Siboga colony is recorded from 274 M. The distal wall is often angulated, as indicated by LEVINSEN, who stated that the spines are variable in number or even wanting. He described a multiporous rosette-plate on each side of the terminal wall, near the basal side, and a single multiporous plate in the distal half of each lateral wall. In the older part of the Siboga specimen the zooecia are short, some being absolutely spineless; and I have found two transversely elongated series of septula on the terminal wall, and lateral multiporous plates, as described by LEVINSEN. As shown in fig. 11, each zooecium forming the commencement of a doubled row usually has a single large proximal spine and a smaller distal spine on the inner side of the middle line of the gymnocyst. These spines are rather long, and are as a rule imperfectly calcified, so that they show a terminal pore. They are rarely completely calcified, with an acute point.

The ovary, visible near the middle of one side of the zooecium, contains a number of eggs; and single eggs of irregular form were found floating freely in the body-cavity. Indications of an intertentacular organ were moreover seen. These appearances, in the light of what has been said above (pp. 200, 203), give reasons for believing that the eggs pass through an intertentacular organ to the exterior and may develop as a *Cyphonautes*. The parietal muscles are in five or six groups on each side.

The following species appear to be referable to *Electra*: —

M. repiachowi Ostr.

M. monostachys Busk.

M. mülleri Bidenkap.

M. devinensis Robertson, 1921, BBB, p. 50. On sodden wood from the Orissa coast, S. W. of Calcutta.

M. defensa Kirkpatrick, 1888, AMNH, 6, I, p. 74. Mauritius.

M. polystachys Kluge, 1914, BDSE, p. 663. Simon's Bay, Cape of Good Hope.

3. **Nichtina** Canu.

Nichtina [1]) Canu, 1900, BSGF, 3, XXVIII, p. 380.
"*Membranipora membranacea* group" Waters, 1898, JLS, XXVI, pp. 661, 665.
Membranipora Levinsen, 1909, MSSB, p. 144.
Membranipora (*pars*) Canu and Bassler, USNMB, 1920, 106, p. 77.

Genotype, selected by the author, *Membranipora membranacea* auctt. (nec *Flustra membranacea* L.) = *F. telacea* Lamarck, 1816, ASV, p. 158. I have given my reasons above (p. 206), for regarding *N. telacea* as the correct name of the genotype.

Encrusting. Zooecia elongated, quadrangular. Gymnocyst slightly developed proximally, giving rise to a pair of tubercles or spine-like processes. Frontal membrane and opesia almost equal to the frontal surface, sometimes surrounded by marginal spines. Cryptocyst wanting or slight. Avicularia, ovicells and pore-chambers wanting. A *Cyphonautes* larva occurs in *N. villosa*.

Nichtina appears to belong to the group, including *Electra*, in which avicularia, ovicells and pore-chambers have at no time been present in the ancestry. Hincks and others have described the paired tubercles as distal structures. The evidence given by Nitsche (1871, ZFWZ, XXI, p. 420) shows that they are proximal structures, as stated by Levinsen (*l. c.*).

The following species may provisionally be referred to *Nichtina*: —

Flustra isabelleana D'Orbigny, 1839—1846, VAM, p. 18.
Membranipora villosa Hincks, 1880, AMNH, 5, VI, p. 84.
Membranipora hyadesi Jullien, 1888, CH, p. 76.
Membranipora hugliensis Robertson, 1921, BBB, p. 51.

A *Cyphonautes* larva is definitely known to occur in *N. villosa*, from the observations of Miss Robertson (1908, ICNA, p. 271, Pl. XVII, figs 24—24*b*, 25), who observed its metamorphosis; and, as pointed out above (p. 200), there is some presumptive evidence that it is found in *N. tuberculata*. Miss Robertson showed that the cellular mass formed by the metamorphosis of the larva divides into two twin zooecia while still covered by the valves of the *Cyphonautes* shell. This curious condition is certainly exceptional, so far as is known, but a "double ancestrula" has been shown to occur also in *N. telacea* by Waters (1925, AMNH, 9, XV, p. 343, Pl. XXI, fig. 1), although he has not described the larva.

1. *Nichtina tuberculata* (Bosc). (Pl. XIII, fig. 10).

Flustra tuberculata Bosc (*pars*), 1802, HNV, p. 118; — 1830, p. 143.
Membranipora tuberculata Busk, 1858, QJMS, VI, p. 126, Pl. XVIII, fig. 4.
Membranipora tuberculata Thornely, 1907, MPIM, p. 185, text-fig. 3. Indian Ocean.
Membranipora tuberculata Norman, 1909, JLS, XXX, p. 286. Madeira, on *Sargassum*.
Membranipora tuberculata Kirkpatrick, 1923, PZS (1922), p. 986, Pl. I, fig. 11.
Membranipora tuberculata Marcus, 1922, SAB, p. 14, text-fig. 8. Algoa Bay.
Flustra tehuelcha D'Orbigny, 1839—1846, VAM, p. 17, Pl. VIII, figs 10—14. Patagonia, on sea-weeds.
Membranipora tehuelcha Waters, 1898, JLS, XXVI, pp. 674, 660, 665. Pl. XLVIII, figs 6, 6*a*, 7, 7*a*, 8.
Membranipora tehuelcha Robertson, 1908, ICNA, p. 265, Pl. XV, figs 16, 17; Pl. XVI, fig. 18. California; — 1921, BBB, p. 47. Orissa Coast, N. E. India; Burma.

1) ? named after Nitsche.

Membranipora tehuelcha Osburn, 1914, CIW, 182, p. 193. Tortugas Is (Florida), on *Sagassum*.
Membranipora tehuelcha Kluge, 1914, BDSE, p. 664, text-fig. 40. Azores, etc., on *Sargassum*.
Membranipora tehuelcha O'Donoghue, 1924, BP, p. 37. Cape of Good Hope.
(?) *Flustra inca* D'Orbigny, 1839—1846, VAM, p. 18, Pl. VIII, figs 17—19. Peru.
Flustra peregrina D'Orbigny, *op. cit.*, p. 18, Pl. X, figs 1—3. Rio de Janeiro, Antilles, Azores, on *Sargassum*.
Membranipora joubini Calvet, 1907, BTT, p. 390. Sargasso Sea, on *Sargassum*.
Amphiblestrum bituberculatum Ortmann, 1899, ANG, LVI, 1, p. 29, Pl. I, fig. 25. Japan.

363. A. Stat. 71. Makassar, S. W. Celebes, "strand", on a sea-weed.

Zooecia variable in proportions, basal wall uncalcified. Operculum not quite distal. A pair of strong, rounded tubercles at the proximal end of each zooecium. Cryptocyst little developed in young zooecia, more extensive in the older state, rather distantly tuberculated. Rosette-plates 2 lateral, multiporous; 2 terminal, or a single row of septula, at least 12 in number, across the entire width of the wall, close to its basal edge.

Authors have not been in agreement with regard to the name which should be used for this species, the characteristic habitat of which is the Gulf-weed, *Sargassum*. Norman (*l. c.*), who quoted the original diagnosis in full, concluded that *tuberculata* must be accepted, on the ground that Bosc's species was found on Gulf-weed. A difficulty occurs in accepting this name, since Bosc stated that the zooecia have "trois dents et un bourrelet à leur ouverture", a description which does not apply to the Gulf-weed species. He gave as a synonym *Flustra dentata* [1]) Abildgaard, in Müller, Zool. Dan., III, 1789, p. 24, Pl. XCV, figs 1, 2 (ref. completed). Abildgaard's description includes the statement "marginibus oppositis tridentatis, ore marginato"; and it seems probable that this was wrongly included by Bosc in his diagnosis of another species. Bosc's name may thus be accepted, on the ground that he was primarily concerned with the species which occurs "en immense quantité sur les fucus nageans sur l'Atlantique".

It is possible that more than one species has been included under *M. tuberculata* and *M. tehuelcha*, but I think it best to accept the conventional view that the two species are identical, though variable. Waters (*op. cit.*, p. 675) has described two, or occasionally one or three, remarkable comb-shaped structures which were found by Mr Kirkpatrick and himself in specimens of *N. tehuelcha* from Angola and San Pedro (W. Africa). I have seen them in the British Museum specimen (77. 3. 7. 16) from San Pedro, and I find that, in agreement with Waters' figure (Pl. XLVIII, fig. 7), they originate from the cryptocyst, on the proximal side of the opesia, and extend nearly vertically towards the basal wall. Waters also described numerous minute, branched spines, which grow from the walls of the zooecia beneath the frontal membrane. Both combs and spines have been described and figured by Kluge (*l. c.*), whose specimens came from the Atlantic; and spines by Miss Robertson (1908) from Californian material. Waters stated (p. 665) that the lateral rosette-plates are 4—6 (*i. e.*, 2—3 on the distal half of the wall), and that septula are numerous on the terminal wall; and Kluge gives a similar account. This agrees with my own observations on the Siboga specimen, but in another from Valparaiso (B.M., 21. 11. 27. 1) I find two multiporous rosette-plates on the terminal wall. In at least one instance, in the Siboga material, the row of terminal septula shows a tendency to break up into

1) *Flustra dentata* Ellis and Solander, 1786, NHZ, p, 15; generally regarded as a synonym of *Electra pilosa*.

two groups (as described by KLUGE), which are hardly different from two multiporous plates. A specimen in the Cambridge Museum (BM.) from Aden (HINCKS Coll., Reg. May 13, 1899), with the general appearance of this species, has a prominent chitinous mammilla projecting from the frontal membrane, on each side, close to the proximal side of the operculum. I have seen no indication of this character in any other specimen.

In the Aden slide above referred to, the tubercles characteristic of this species reach a large size, but remain as half tubes, the open side directed distally, and the membrane which closes them continuous with the frontal membrane on the same side of the tubercles. Miss THORNELY (*l. c.*) seems to imply the same thing, and in the Siboga specimen also I find that the tubercle does not completely close at its base distally, where its membrane remains continuous with the frontal membrane. The tubercles in this specimen are for the most part distinct, without fusing into a single mass, as described by D'ORBIGNY in old examples, and often noted by later writers. I have found evidence that the ovary contains numerous eggs (which is also the case in *N. telacea*), and that irregular, isolated eggs occur free in the body-cavity. These facts indicate that ovicells are constantly absent and that the larva may be a *Cyphonautes*.

4. **Conopeum** Gray.

Conopeum Gray, 1848, BMRA, pp. 108, 146.
Conopeum Norman, 1894, AMNH, 6, XIII, p. 114; — 1903, AMNH, 7, XI, p. 586.
Conopeum Canu and Bassler, 1920, USNMB, 106, pp. 84, 86.
Normanellina [1]) Cossmann, 1920, Rev. Crit. Paléozool., XXIV, p. 83.
Monotypical. Genotype, *Millepora reticulum* L., 1767, SN, p. 1284.

Encrusting. Gymnocyst frequently with a pair of triangular depressions, which, like the gymnocyst, may be wanting. Frontal membrane and opesia typically oval, the cryptocyst extending round the entire margin, and tuberculated. Avicularia, ovicells and pore-chambers wanting.

Millepora reticulum L. was described from shells in the Mediterranean, but LINNAEUS did not understand its structure, since he stated that it consists of a fine anastomosing network, like a spider's web, and that he found no pores. ESPER (1789, Pflanzenthiere, I, p. 205; *Millepora*, Pl. XI, figs 1, 2) gave a similar account, referring to specimens on the shells of *Mytilus*, also from the Mediterranean; and this habitat is very characteristic of the species known as *Membranipora lacroixii* in British waters. It is probable that both accounts were based on dead specimens, from which the frontal membrane had disappeared, and that the edges of the calcareous walls of the zooecia constituted the network in question. It may thus be concluded that the genotype is *Millepora reticulum* L. NORMAN (1894, 1903) stated that, on the result of his examination of the specimens in the British Museum, GRAY's original material belongs to *M. lacroixii* Aud. LEVINSEN (1909, MSSB, pp. 146, 144) considered that *M. lacroixii* auctt. is not identical with AUDOUIN's species with the same trivial name, and he accordingly proposed to term it *M. hippopus*. SAVIGNY's figure (Descr. Égypte, Pl. X, fig. 9[2]) includes structures which appear to be shallow ovicells, reversed in position, and it seems best therefore to accept LEVINSEN's conclusion, but not his name, on the ground that a LINNEAN name is available.

1) Unless COSSMANN supposed *Conopeum* Gray to have been a Mollusc (which appears probable), I see no reason for the introduction of *Normanellina*, which has been misquoted by DUVERGIER as *Normaniella*.

1. *Conopeum reticulum* (L.). (Pl. XIII, fig. 12).

Millepora reticulum Linnaeus, 1767, SN, p. 1284. Mediterranean.
Millepora reticulum Esper, 1789, Pflanzenth. I, p. 205; *Millepora*, Pl. XI, figs 1, 2. Mediterranean and East Indian Seas.
Flustra peachii Couch, 1841, 9th Ann. Rep. R. Cornwall Polytechn. Soc., p. 81. Cornwall.
Conopeum reticulum Gray, 1848, BMRA, p. 108. Britain.
Membranipora lacroixii (*pars*) Busk, 1854, BMC., p. 60, Pl. LXIX, figs 1—5 (not Pl. CIV, fig. 1[1]).
Membranipora lacroixii Hincks, 1880, BMP, p. 129, Pl. XVII, figs. 5—8.
Membranipora lacroixii Haswell, 1880, PQC, p. 38. Queensland.
Membranipora lacroixii Philipps, 1899, WZR, p. 440. New Britain.
Membranipora lacroixii Robertson, 1908, ICNA, p. 261, Pl. XIV, fig. 5. California, Alaska; — 1921, BBB, p. 46, Orissa Coast, Bay of Bengal.
Membranipora lacroixii Osburn, 1914, CIW, 182, p. 193. Tortugas Is Florida.
Membranipora lacroixii O'Donoghue, PVIR, 1923, p. 167. Vancouver Id region (var. *triangulata*).
Biflustra aciculata MacGillivray, 1891, PRSV (N. S.) III, p. 79, Pl. IX, fig. 5. New South Wales.
Membranipora hippopus Levinsen, 1909, MSSB, p. 146 (see also p. 144).
Membranipora hippopus Annandale, 1915, MIM, V, p. 123. Chilka Lake, N. E. India.
Conopeum lacroixii Norman, 1903, AMNH, 7, XI, p. 586.
Conopeum lacroixii Barroso, 1923, BSEHN, XXIII, p. 121, text-figs 2—4. Spain.
Conopeum lacroixii Canu and Bassler, 1920, USNMB, 106, p. 89, text-fig. 25, *A, B*, Pl. XIII, fig. 9.
Conopeum lacroixii Kirkpatrick, 1923, PZS (1922), p. 986, Pl. I, figs 8, 10.
Membranipora reticulum Marcus, 1922, ASNG, XXXV, p. 426. Aru Is, Java, Sumatra, Burma, Red Sea, Japan, etc.

405. A. Stat. 258. Kei Is. reef. On a living Gasteropod shell.
552. A. Stat. 313. Saleh Bay, N. Sumbawa. 0—36 M. Same habitat.

British Museum: —

British specimens referred to by GRAY (l. c.) Johnston Coll.
Cochin Backwater, 09. 8. 6. 1, Dr. N. ANNANDALE. (And other specimens).

Encrusting. Zooecia quincuncial, outlined by a distinct chitinous line, variable in shape, typically longer than wide, the ratio between the two measurements variable. Cryptocyst equally developed all round, strongly tuberculated, some of the tubercles projecting into the opesia as acute conical processes. Proximal triangular depressions (commonly found in this species) barely distinguishable and at most vestigial. Oral arch very slightly raised, nearly straight, the insertion of the terminal wall into the basal wall straight or slightly convex distally. Opesia varying in the ratio of the two axes, sometimes regularly oval and short, more often an elongated oval in which the proximal and distal ends are alike, or either wider than the other.

The synonymy given above might have been greatly extended, but I have restricted it to works giving satisfactory descriptions or figures, and to those which are of special interest in illustrating the history or distribution of the species, particularly in the vicinity of the Siboga area. Some of the determinations are doubtfully correct, but the species, which has no strongly marked characters, appears to be of wide distribution, and subject to considerable variation.

In one or two zooecia of 405. A, I have found a considerable number of very small eggs, in an ovary resembling that shown by PROUHO (1893, AZEG, 2, X, Pl. XXV, fig. 26) in *Electra pilosa*. This observation suggests that a *Cyphonautes* may occur in the life-history, an

1) BUSK's specimen, 54. 11. 15. 219, which is marked St Vincent, Cape Verde Is, Pl. 104, has small vicarious avicularia, hyperstomial ovicells, and several short marginal spines; and it cannot be regarded as belonging to the present species.

idea which gains additional probability from the discovery by ANNANDALE (1915, p. 124) of a *Cyphonautes*, in the Chilka Lake, which there was some reason for referring to the present species.

The triangular depressions, sometimes roofed over and converted into a pair of rounded eminences (Cf. HINCKS, 1880, Pl. XVII, fig. 6) are just recognisable, in a vestigial condition, in one or two zooecia of the present material. KIRKPATRICK (1923, p. 986) has suggested that these and many other structures represent aborted buds, and that they are thus vestigial zooecia. A similar view had previously been put forward by JULLIEN (1886, BSZF, XI, p. 607, note 2), who proposed the term "origella" for a bud of the soft tissues which may give rise to anything from a simple pore in the ectocyst to a complete zooecium or avicularium. The depressions, which may be converted into definite eminences, are probably comparable with the paired tubercles of the gymnocyst of *Nichtina*, and they correspond in position with the avicularia of certain other genera. I think it should not be inferred that they represent vestigial avicularia, as I believe *Conopeum* to be a genus in which avicularia have not yet appeared.

2. *Conopeum eriophorum* (Lamx.). (Pl. XIII, fig. 9).

Flustra eriophora Lamouroux, 1816, PCF, p. 110, Pl. I, figs 5,*a*,*B*. Australasia.
Flustra eriophora Milne-Edwards, 1836, ASV, p. 225.
Reptelectrina eriophora D'Orbigny, 1852, PFTC, p. 334.
Membranipora spinostoma Robertson, 1921, BBB, p. 47, text-fig. 45. Persian Gulf, 13 fath.
(?) *Membranipora favus* Hincks, 1884, AMNH, 5, XIII, p. 357, Pl. XIII, fig. 2. Burma.

378. C. Stat. 71. Makassar, S. W. Celebes, 0—32 M. On a Gasteropod shell.
132. A. Stat. 164. W. of N. end of New Guinea, 32 M., on a Gorgonian.
345. B. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
192. A. Stat. 274. Off Jedan, Aru Is, 57 M., on a Gorgonian.

Cambridge, Mus. Zool.:

Singapore, from a submarine cable. Prof. C. STEWART, Reg. Apr. 26, 1899.

Encrusting. Zooecia deep, in distinct longitudinal lines, quincuncial or with the zooecia of adjacent rows at the same level, not much longer than wide. Frontal membrane covering the entire surface, gymnocyst wanting. Orifice subterminal, the operculum wider than long, with a strongly developed marginal sclerite; bearing numerous spines, directed distally when closed, proximally when open; a pair of long spines commonly present on the lateral parts of the operculum, one on each side, often directed proximally even when the other spines point distally. A series of much smaller spines, varying in number, on other parts of the frontal membrane, usually over the edge of the opesia. Opesia longitudinally oval or nearly circular. Cryptocyst developed all round the opesia, slightly wider proximally, strongly tuberculated in the old condition. Rosette-plates multiporous, near the frontal wall; one on each side of the terminal wall, a single plate on the distal half of each lateral wall.

This species was well described by the late Miss ROBERTSON, who stated that the long lateral opercular spines grow in sockets and are movable, either proximally or distally; but I think that her species is identical with *Flustra eriophora* Lamx. Cleaned pieces resemble *Membranipora favus* Hincks (*l. c.*), also with very deep zooecia, recorded from Burma, but without a satisfactory description of the membranous parts. One at least of the Siboga specimens

shows reduced zooecia of the kind described by this author. *M. favus* was recorded later by Miss THORNELY (1905, PGM, p. 110) from Ceylon; and, as *M. normaniana*, in 1912 (PIOS, p. 142) from the Amirante and Providence Is, Indian Ocean. A specimen of "*M. favus*" in the Cambridge Collection, sent by her from Ceylon, appears to belong to *Acanthodesia savartii*.

The occurrence of spines on the operculum is a very unusual feature, but they occur in *Membranipora bengalensis* Stoliczka, where, accordingly to Miss THORNELY (1907, MPIM, p. 186, text-fig. 4), a pair of large, bifurcated spines are found in this position. The locality given by her is wrong, as appears from a correction by ANNANDALE (1911, Fauna of British India, Freshwater Sponges, Hydroids and Polyzoa, p. 175 note), who states that the specimens examined by her were the type-specimens from Port Canning (Ganges Delta).

5. **Acanthodesia** Canu and Bassler.

Acanthodesia Canu and Bassler, 1919, CIW, 291, p. 79; — 1920, USNMB, 106, pp. 84, 99; — 1923, USNMB, 125, p. 30.

Genotype, indicated by the authors, *Flustra savartii* Aud., 1826.

Encrusting, Hemescharan, Escharan, Cellariiform or Vincularian. Zooecia usually without gymnocyst, the frontal membrane occupying the entire surface; typical marginal and oral spines wanting. Cryptocyst most developed proximally, this portion often with a simple or denticulate process projecting into the opesia; narrower laterally and distally. Adventitious avicularia, ovicells and pore-chambers wanting. Incipient vicarious avicularia found in certain species.

The original definition was "No ovicell. The opesium is garnished laterally by small spinous processes and inferiorly by a serrate denticle. 15 tentacles". The number of tentacles can hardly be retained in the diagnosis if fossil species are placed in the genus, a course adopted by CANU and BASSLER. The "spinous processes" can hardly be included, since it is stated in the original account that "they have not been noted in the recent specimens", to which group the genotype [1]) belongs. The genus appears to be related to *Conopeum*; but can be distinguished from it by the absence of a gymnocyst (in most of the species), by the greater development of the proximal cryptocyst, and by the narrower distal cryptocyst. The occurrence of incipient vicarious avicularia in three species of Vincularian habit is of special evolutionary interest.

1. *Acanthodesia savartii* (Aud.). (Pl. XIII, figs 8, 13, 14, 16).

Flustra savartii Audouin, 1826, EPS, p. 240; — 1828, p. 69; — SAVIGNY, DE, Pl. X, figs 10^1, 10^2. Egypt.
Membranipora savartii D'Orbigny, 1853, PFTC, p. 542.
Membranipora savartii Waters, 1898, JLS, XXVI, pp. 660, 669; — 1909, JLS, XXXI, p. 137, Pl. XI, figs 8—13. Red Sea; — 1913, PZS, p. 486, Pl. LXXI, figs 1—4. Zanzibar.
Membranipora savartii Thornely, 1912, PIOS, p. 143. Indian Ocean.
Membranipora savartii Osburn, 1914, CIW, 182, p. 194. Tortugas Is (Florida).
Membranipora savartii Marcus, 1921, IPBS, p. 6. Java.
Membranipora savartii Canu, 1908, AMNBA, XVII, p. 252, Pl. II, figs 5, 6. Post-Pampean, Argentina.

1) Spinules are figured by SMITT (1873, KVAH, XI, N° 4, Pl. IV, fig. 92) in specimens which I refer doubtfully to this species

Membranipora savartii Waters, 1887, AMNH, 5, XX, p. 181. Palm Id, Queensland; — and var. *quadrilatera*, p. 182, Pl. IV, fig. 8. Torres Straits.
(?) *Biflustra savartii* Smitt, 1873, KVAH, XI, N° 4, p. 20, Pl. IV, figs 92—95. Florida.
Biflustra savartii Busk, 1884, Chall., p. 67, Pl. XIV, figs 2, 2*a*. Philippine Is., 10 faths.
Acanthodesia savartii Canu and Bassler, 1919, CIW, 291, p. 79; — 1920, USNMB, 106, p. 100, Pl. XXI, figs 2—4; — 1923, USNMB, 125, p. 31, text-fig. 2, *A—I*; — 1925, MSNM, X, p. 12. Morocco (Atlantic).
Biflustra ramosa D'Orbigny, 1852, PFTC, p. 244. Manilla.
Membranipora corrugata de Blainville, 1830, DSN, p. 412; — 1834, MA, p. 447.
Biflustra delicatula Busk, 1859, FPC, p. 72, Pl. I, fig. 1 (recent) Australia, Manilla?; fig. 2. English Crag.
Biflustra delicatula MacGillivray, 1881, PZV, VI, p. 28, Pl. LVII, figs 2—3*b*. Queensland, Victoria.
Biflustra delicatula Namias, 1892, ASNM, 3, XI, p. 76. Red Sea.
Membranipora delicatula Hincks, 1880, AMNH, 5, VI, p. 86, Pl. XI, fig. 1. Florida.
Membranipora delicatula Thornely, 1907, MPIM, p. 186. Mangalore, S. W. India.
Membranipora favus Thornely, 1905 (nec Hincks), PGM, p. 110. Ceylon.
Membranipora normaniana Thornely, 1906, PGMC, p. 449.
Membranipora crenulata Okada, 1923, AZJ, X, Pt 3, p. 224, fig. 24. Japan.

Waters (1905, AMNH, 7, XV, pp. 5, 11, 12) states that *Biflustra ramosa* D'Orbigny (1852, PFTC, p. 244), *Flustrellaria candeana* D'Orb. (1853, PFTC, p. 515) and *Membranipora malaccensis* D'Orb. (*t. cit.* p. 543), from Manilla and Malacca, belong to *A. savartii* or to an allied species.

384.A. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
37. C. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
457.A. Stat. 79a. Borneo Bank, Strait of Makassar, 54 M. (Partly var. *quadrilatera* Waters).
73.A., 617. F. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.
396.M., 598.A. Stat. 162. Off Loslos Id., N. end of New Guinea, 18 M. On Hydroid and *Scrupocellaria*.
132. B., 399. C. Stat. 164. W. of N. end of New Guinea, 32 M.
144. B. Stat. 166. W. of N. end of New Guinea, 118 M.
344.D. Stat. 213. Saleyer, S. of Celebes, 0—36 M. Encrusting and Vincularian.
292.A., 308.A., 316.A. Stat. 273. Jedan, Aru Is., 13 M. Encrusting, Hemescharan and Escharan.
193. B. Stat. 274. Off Jedan, Aru Is., 57 M. Partly on *Retepora*.
419.A. "On the Siboga".

Cambridge, Mus. Zool.: —

BM Ceylon, L. R. Thornely Coll., Reg. Apr. 25, 1906, 11. Determined by Miss Thornely as *Membranipora favus* Hincks, but resembling 344. D. of the Siboga Collection.
Malay Peninsula, W. W. Skeat Coll. Reg. Nov. 30, 1899.
Malay Peninsula, Singora Lake, brackish water. Same Coll.
Singapore, from a submarine cable. Prof. C. Stewart, Reg. Apr. 26, 1899.
Singapore, 5—10 faths, F. P. Bedford Coll., Reg. Nov. 11, 1899.
Philippine Is., 10 faths, Challenger Coll., Stat. 212. Received from British Museum, Reg. Nov. 18, 1899. Escharan.
China, G. Busk Coll., Miss E. C. Jelly, Reg. May 24, 1895. Escharan.
Queensland, Miss E. C. Jelly, Reg. May 24, 1895.
Queensland, from Coll. described by Prof. W. A. Haswell. Australian Mus., Reg. Oct. 23, 1899.
Torres Straits, A. C. Haddon, Reg. Feb. 24, 1898.

Unless otherwise indicated, the specimens are encrusting.

Encrusting, Hemescharan, Escharan, Cellariiform or Vincularian. Zooecia in very regular, longitudinal lines, in which they frequently increase distally to a zooecium which gives off two much narrower distal successors; typically short and wide, the distal edge slightly raised, curved or angular. Operculum nearly terminal, spines wanting. Opesia at first oval and occupying most of the frontal surface; later invaded by a cryptocyst, at first smooth, which fills its proximal part and then extends along its sides and round its distal border, where it is but slightly developed. In the old state the cryptocyst becomes thickened and bears distant tubercles, some of which may form denticles projecting into the opesia laterally. A large proximal denticle, variable in size and form, usually present, but sometimes only appearing in the older zooecia. Basal surface simple, the terminal walls inserted into it in a straight or curved transverse line. Rosette-plates typically 2 in the distal half of each lateral wall, multiporous; a transverse row of septula on the terminal wall, sometimes aggregated to form multiporous plates.

The augmentation in size of the zooecia (fig. 14), along the longitudinal rows, is characteristic of this species, though it is not always marked. In extreme cases the last zooecium before the bifurcation of a row is wider than long. The augmentation is well shown by Savigny (fig. 10[2]) and is alluded to by other authors (MacGillivray, 1881; Canu, 1908). At the growing margin, the septation which divides the zooecia from one another may be of the type described by Nitsche (1871, ZFWZ, XXI, Pl. XXXV, fig. 5) in *Nichtina telacea*; the undivided longitudinal row being as long as three or four zooecia. In less actively growing specimens, the undivided parts are not nearly so long.

The proximal denticle is variable, but there are few cases in which I have not found it in some of the zooecia at least. It sometimes occurs in a few zooecia only, usually the older ones; but in other colonies it is present even in very young zooecia. It may be merely linear and simple, but it is more often terminated by fine teeth (fig. 8), and in some specimens it becomes very wide, with numerous teeth, and extends across the whole width of the proximal part of the opesia.

Waters (1913) has described a great development of the funicular tissue in this species, and I have myself found this condition in certain colonies suitably prepared, but the quantity is not always excessive. The retractor muscles usually originate from one of the proximal lateral corners of the zooecium, where the oesophageal part of the retracted polypide is generally found. Canu and Bassler state (1919, p. 79) that the "large retractor muscle of the polypide inserted on the median axis of the zooecium assures the symmetry of the opesium". This assumed relation of the origin of the retractors to the symmetry of the opesia, frequently referred to in their diagnoses, seems to me unwarranted by the evidence. Thus in the Siboga specimen 292. A, I find that the origin of the retractors, in the great majority of cases, is at one of the proximal angles. In some zooecia there is a marked asymmetry in the position of the opercula, which are so placed that their base-line is at right angles to the direction of the retractors. The main axis of the oval opesia may be correspondingly oblique; and the facts are so far in accordance with the statement quoted above. But the generalisation breaks down in other cases in which, although the retractors have a similar origin, there is no recognisable asymmetry, either in the position of the operculum or of the main axis of the opesia, both of which are strictly symmetrical.

In some few instances the retractors originate at or close to the median line of the zooecium, and in these cases the operculum and the opesia are symmetrical. Zooecia of this type usually occur between two zooecia, in a longitudinal line, in which the retractors originate in opposite corners. In 308. A, from the same Station, the proportion of zooecia in which the retractors originate at or near the middle line of the zooecium is much higher, but asymmetry of the operculum and opesia is hardly apparent, even in those in which the retractor-origin is from one of the proximal corners. It is clear that, in this material at least, the origin of the retractors is from a proximal corner, on either side, or from any point between the middle line and one of the corners; but that the variation in position of the origin is not necessarily associated with the symmetry or asymmetry of the zooecium.

457. A is a specimen encrusting an Echinid spine, and giving off erect, bifurcating, Cellariiform branches, in which the zooecia may be in four rows, each facing one of the surfaces of the quadrilateral stem, but sometimes increasing to more than four rows. Chitinous joints occur in these stems, the base of the next internode being narrow. This specimen corresponds with var. *quadrilatera* Waters, 1887.

344. D, found on Adeonidae, is partly encrusting and partly Vincularian in habit. The Polyzoa on which it is growing have narrow, flattened branches, and its own erect portions seem to have originated owing to the necessity of taking on a free mode of growth, on reaching the end of the surface available for the encrusting base. On leaving the substratum the basal walls of opposite sides come into contact with one another, forming at first a bilaminar region. The free branch then usually contracts in diameter, assuming a cylindrical, unjointed form, with the zooecia arranged in 6—8 longitudinal rows. In this condition the growth may be prolonged, with several bifurcations, where a slight multiplication of the rows occurs, the branches returning later to the cylindrical form. They are occasionally trifurcate, and may anastomose where they meet one another, the zoarium thus becoming fenestrate, as shown by Waters (1909, Pl. XI, fig. 10). Some of the cylindrical branches expand into broader, bilaminate, palmate portions, giving off several cylindrical branches from the distal edge. This specimen shows instructive evidence of the manner in which a Cellariiform or Vincularian mode of growth may originate in an encrusting species, but the zooecia have typical characters in all its parts.

1a. *Acanthodesia savartii* (Aud.), var. *cetrata* [1]) nov. (Pl. XIII, fig. 15).

555. D. Stat. 320. Java Sea, 82 M.

Mainly Vincularian, unjointed, bifurcating once or twice, the zooecia in 4 or 6 rows; commencing as an encrustation on a Hydroid. Zooecia short in the encrusting part, much elongated in the free branches, where the proximal cryptocyst is long, about equalling the length of the opesia. Margin raised, nearly smooth, arched distally. Opesia invaded by a very large, thin, median process, bearing three or four long teeth on each side and several on its distal border, the teeth curved basally. Rosette-plates 2—2 laterally, and probably 1—1 distally, multiporous, with a reduced number of pores.

The zooecia of the short encrusting region are not longer than in typical *A. savartii*,

1) *cetratus*, armed with a shield.

but the median process, figured in the Vincularian part, is similarly developed in the encrusting part, though naturally not quite so long. It may perhaps prevent the frontal membrane from being drawn too far down by the contraction of the parietal muscles. The reference of 555. D to *A. savartii* is confirmed by 396. M, entered under the typical form. This was growing on a Hydroid and on *Scrupocellaria*; and while having normal zooecia the median process is developed in much the same way as in the variety, though to a smaller extent. In both 555. D and 396. M the lateral cryptocyst may give off one or two teeth, projecting into the opesia, of a similar nature to those of the median process.

The median process of this variety closely resembles that of *Membranipora danica*, var. *scutata* Levinsen (1894, ZD, p. 54, text-fig. 2).

2. *Acanthodesia limosa* (Waters). (Pl. XIII, fig. 17).

Membranipora limosa Waters, 1909, JLS, XXXI, p. 140, Pl. XII, figs. 1—5. Sudanese Red Sea.
Membranipora limosa Levinsen, 1909, MSSB, p. 145, Pl. XXII, figs 5 *a—c* (*Electra normani* n. sp. on Plate) Formosa Channel, 30 faths; Nagasaki (Japan).
Membranipora limosa Marcus, 1921, IPBS, p. 7. Between Singapore and Batavia.
Acanthodesia limosa Canu and Bassler. 1909, CIW, 291, p. 79; — 1923, USNMB, 106, p. 30, text-fig. 2, *J—L*.

431. A. Stat. 2. Madura Strait, 56 M.
553. B. Stat. 313. Saleh Bay, N. Sumbawa, 0—36 M.
625. A. Stat. 319. Java Sea, 82 M.

The trivial name was taken from the occurrence of this species on a muddy bottom, which occurred also in all three of the Siboga dredgings.

British Museum: —

Formosa Channel, 10. 10. 29. 1, G. M. R. Levinsen.

Slightly encrusting at the base, rising at once into quadriserial erect branches, square in transverse section, each surface with a single row of zooecia; a median series interposed on each of two opposite surfaces before a bifurcation, so that the arrangement is here 6-serial. Branches imperfectly jointed at the base. Zooecia oblong, the frontal membrane of nearly the same width throughout, the oral arch curved, thin, not raised; spines wanting. Horizontal cryptocyst commencing below the thickened edges in the young state, and then nearly smooth; becoming tuberculated later and passing continuously into the thickened margins; well developed proximally, not so wide laterally, and forming a small proximal tooth, simple or slightly denticulate, projecting into the opesia distally. Operculum relatively long, with a distal marginal sclerite, its lateral margins straight or approaching one another proximally; occasionally enlarged and suggesting the mandible of an incipient vicarious avicularium. Rosette-plates typically 2 or 3 in the distal half of the lateral wall, multiporous, with a reduced number of pores; the terminal plates forming an arc, open frontally, of single pores, some of which may be grouped to form compound plates.

This species has been well described by both Waters and Levinsen. Waters calls attention to the kenozooecia which help to form the imperfect joints. In some cases I find these

as described by him, without an operculum (his fig. 3), but in other cases the unit is a complete zooecium, with operculum and polypide. LEVINSEN figured the terminal rosette-plate (fig. 5 *b*), and certain calcareous rods, hooked at the end (figs 5 *b*, *c*), which project into the body-cavity from the distal side of the terminal wall. I have found the bases of these spines, but not the hooked ends, which were probably broken off.

The zooecia care three-sides prisms, one edge of which coincides with the axis of the branch. The shape of the arc-like series of terminal septula is probably correlated with the absence of a basal wall. I agree with WATERS in thinking that the affinities of this species are probably with the *savartii*-group, and with CANU and BASSLER in referring it to *Acanthodesia*.

3. *Acanthodesia nelliiformis* n. sp. (Pl. XIII, figs 20—22).

4. B. Stat. 12. S. of Kangeang Id., 289 M.

Erect, in habit closely resembling *Nellia oculata*, composed of long, occasionally anastomosing, bifurcating branches, which are straight or slightly curved, quadriserial, square in transverse section, one series of zooecia corresponding with each face. Internodes long, parallel-sided, composed of as may as 20—30 pairs of zooecia. Well developed chitinous joints at the base of each branch at a bifurcation. Zooecia elongate, hexagonal, the oral arch not appreciably raised. Sides curved outwards, raised, with a marked, longitudinal, smooth, thickened band of cryptocyst on the inner side of the edge. Horizontal cryptocyst very extensive proximally, smooth, its middle portion much depressed, descending distally towards the basal wall, varying in width but frequently narrow, parallel-sided. Distal wall with a marked slope, from the oral arch in a proximal direction basally, corresponding with the basal overlap of the succeeding zooecium. The zooecia of two opposite rows meet basally, along an elongated spindle-shaped region, the widest part of which is near the level of the proximal margin of the opesia, the spindle decreasing in width proximally and distally from this point, so that the union of the two zooecia is narrower or even linear below the oral arch. Zooecia of the other two rows not quite meeting basally. Opesia short, less than half the length of the zooecium, rounded proximally, truncated by the oral arch distally. Vicarious avicularia with an enlarged and raised oral arch, which commences on each side with a small condyle; regularly curved or with the sides partially straight. Opesia much larger than in the zooecia. Mandible (fig. 22) very broadly spatulate, with basal and main sclerites. Terminal rosette-plate single, median, at the extreme basal angle of the wall, multiporous, the pores in an arc open frontally. Lateral rosette-plates?

This species has a considerable resemblance to *A. limosa*, and it may, I think, be placed in the same genus. It differs from it in its smooth cryptocyst, in the greater development of the proximal part of that layer, and in the occurrence of highly modified opercula on certain zooecia, which may be considered incipient vicarious avicularia. As is usual in Membraniporidae, when these structures occur, the enlarged opercula have a basal sclerite (fig. 22), from which are given off the two parts of the main sclerite, uniting to form an arch. The opercula (fig. 20) are much smaller, without basal sclerite, the distal and lateral margins being strengthened by a crescentic thickening, the inner edge of which appears, in frontal view, as a sharply defined line. The fact that only two of the series of zooecia meet basally is noteworthy. The chitinous joints

are formed, as in other jointed Polyzoa, across the zooecia, the proximal parts left associated with the parent-internode being very short. In most cases all four series are involved, so that four parallel chitinous tubes occur, and the proximal end of the internode shows four calcareous tubes. In other cases two opposite zooecia are not concerned in the formation of the joint, and there are then two chitinous tubes and two calcareous tubes. A curious form of anastomosis of the branches frequently occurs. The tip of a branch applies itself to the side of another branch, all four zooecia uniting firmly with it. A chitinous joint is then formed at a short distance from the point of union, where there is a small calcareous mound constituted by the parts of the four zooecia on the distal side of the joint.

4. *Acanthodesia arctata* [1]) n. sp. (Pl. XIII, figs 18, 19).

492. A. Stat. 150. E. of Halmaheira (Djilolo), 1089 M. One fragment.
Type. 158. A. Stat. 221. Banda Sea, 2798—3112 M. One colony.

Agreeing closely with *A. nelliiformis* in habit, mode of branching, the exclusion of two opposite rows of zooecia from basal contact, and the general shape of the zooecia and of their operculum, frontal membrane, cryptocyst and opesia. Distinguished from that species by (a) the vicarious avicularia, in which the rostrum and mandible are narrow and pointed; (b) the slight development of the lateral cryptocyst and the wider depressed portion of the proximal cryptocyst; (c) the more elongated zooecia and their greater length in proportion to the breadth.

Although the two species must be considered closely allied, the differences between the avicularia seem to demand their separation. In *A. arctata* the rostrum is much more raised laterally than in the other species, while distally it is not much elevated, thus affording room for the apex of the curved mandible. The arch formed by the main sclerite of this structure curves inwards, on each side near its base, or is there straight; and then becomes an acute triangle. The basal sclerite is well developed. The occurrence of two types of avicularia in two closely related species seems to be comparable with the corresponding differences of the "*B*" zooecia (probably incipient vicarious avicularia) of *Steganoporella*. The lateral thickenings of the cryptocyst found in *A. nelliiformis* are only slightly indicated, and the depressed horizontal cryptocyst is correspondingly wider. The opesia is distinctly larger than in the other species. Although joints are present at the bifurcations, the calcareous layer is traceable as an attenuated film over the chitinous tubes, which are four or two in number, but this appears to indicate merely that the joint has not been completed. The distal wall is more oblique than in *A. nelliiformis*, and the number of pores (3 observed) of the terminal rosette-plates is smaller. Some of the isolated zooecia are triangular prisms, while others show a spindle-shaped basal wall, since the two pairs of opposite rows are dissimilar in their relation to the axis of the internode. I have found no indication of anastomosis of the branches. The maximum number of pairs of zooecia observed in an internode is 16.

In the absence of vicarious avicularia, the reference of 492. A to this species is not quite certain.

1) *arctatus*, narrow, in allusion to the form of the mandible.

5. *Acanthodesia simplex* (Busk). (Pl. XIII, fig. 23).

Salicornaria marginata Busk, 1852, VR, p. 367. Torres Straits, 9 faths.
Nellia simplex Busk, 1852, BMC, p. 19, Pl. LXV, fig. 1; Pl. LXV (bis) fig. 3. Same locality.
(?) *Nellia simplex* MacGillivray, 1887, PRSV, XXIII, p. 201. Victoria.
Farcimia simplex Kirkpatrick, 1890, TS, p. 611. Torres Straits.

The following synonyms appear to me improbable or doubtful: —

Nellia simplex Busk, 1884, Chall., p. 27, P. V, figs 6, 6*a*, S. W. of Canary Is., 1675 faths.
Nellia simplex Kirkpatrick, 1888, AMNH, 6, I, p. 73, Pl. IX, fig. 4. Mauritius.
Nellia (?) *simplex* Levinsen, 1909, MSSB, p. 121. Formosa Channel, 35—170 faths; Mauritius (KIRKPATRICK's material), Pl. XXII, fig. 6*a*.

Cambridge, Mus. Zool.: —

Torres Straits, 112. 226. A. C. HADDON, Reg. Feb. 24, 1898.

British Museum: —

Torres Straits, 54. 11. 15. 258 (type of *S. marginata* and *N. simplex* Busk). 99. 7. 1. 641. 642. Same material.

Erect, jointed at the bifurcations. Internodes not very long, typically 4-serial and square in transverse section; an additional row of zooecia occasionally intercalated; sometimes narrower at the base, where the internode may consist of only two zooecia. Zooecia elongate, the edges moderately raised. Gymnocyst moderate in some of the zooecia near the proximal end of the internode, where an asymmetrical foramen is borne. Frontal membrane oval, narrower proximally, usually occupying practically the entire surface, except for a minute triangular proximal region, on each side. Opesia oval, reduced by an extensive development of smooth cryptocyst proximally, extending as a narrow border up the sides of the zooecium. Distal wall very oblique. Avicularia wanting.

The two specimens described are from BUSK's type-locality; but the material is scanty. The foramen seems to be always unpaired, as shown in fig. 23. The lateral rosette-plates are typically two in the distal half of the zooecium, and are either multiporous or uniporous. Terminal rosette-plate as in *A. nelliiformis*. Four or five chitinous tubes usually present in a joint. The spindle-shaped basal walls of two opposite zooecia do not extend along their entire length, so that the basal surfaces of the zooecia of the other two series are in contact with one another.

This species was originally described by BUSK as *Salicornaria marginata*, but he altered the name, later in the same year, to *Nellia simplex*. It may be presumed that his reason for substituting a new trivial name was the fact that he considered it antedated by *Cellaria marginata* (v. Mstr), as described by REUSS (1847, FPWT, p. 59).

It might have been possible to place *A. simplex* in *Nellia*, as was done by BUSK. It resembles it in its habit, and in the manner in which the basal walls of the members of a pair meet one another. It differs from it, on the other hand, in the characters of the rosette-plates and in the want of avicularia, unless the asymmetrical proximal foramen (which is probably for a rootlet) represents one of the avicularia of *Nellia* reduced to a vestige. On the whole I think it is better to place it in *Acanthodesia*.

6. **Caleschara** MacGillivray.

Caleschara MacGillivray, 1880, PZV, V, p. 45.
Caleschara Hincks, 1881, AMNH, 5, VII, p. 152; — 1887, AMNH, 5, XIX, pp. 161, 163; — 1891, AMNH, 6, VIII, p. 173.
Caleschara Busk, 1884, Chall., p. 76.
Caleschara Levinsen, 1909, MSSB, p. 152.
Monotypical. Genotype, *Eschara denticulata* MacGillivray, 1869, PRSV, IX, p. 138.

Frontal membrane occupying the entire surface, the operculum small and Membraniporine. Spines wanting. Cryptocyst extensive, imperforate, tuberculate, its proximal part produced into a Steganoporelliform median process, free distally or uniting with the lateral cryptocyst. Opesia trifoliate, or opesiules complete, according to the character of the median process. Avicularia wanting. Ovicells entozooecial, large. Communication-plates uniporous septula.

Hincks, who expressed several different opinions with regard to the systematic position of *C. denticulata*, suggested (1881) that MacGillivray's genus was invalid because the characters given were inadequate. This view cannot be upheld, as MacGillivray had given as his genotype a species, with strongly marked characters, which deserves generic recognition. The Siboga species described below has a general resemblance to *Steganoporella*, from which it is distinguished by important morphological characters, such as the absence of dimorphism of the ordinary zooecia, the small operculum, the presence of ovicells and the simpler median process. The genus appears to belong to the Membraniporine series, but I cannot agree with Levinsen that one of its synonyms is *Rosseliana* Jullien (1888, CH, p. 78), of which the genotype is *Flustra rosselii* Audouin (1826, EPS, p. 240). *C. parva*, no doubt correctly referred to the genus, was described by Maplestone (1900, PRSV, N. S., XIII, p. 4), from a Tertiary formation in Victoria, and the recent *Steganoporella minuta*, described by the same author (1909, PRSV, N. S., XXI, p. 412), from the Gilbert Is., appears to be also referable to *Caleschara*.

1. *Caleschara levinseni*[1]) n. sp. (Pl. XIV, fig. 1).

(?) "undescribed species [of *Caleschara*] from Siam", Levinsen, 1909, MSSB, p. 152.

488. C. Stat. 133. Lirung, Talaut Is., S. of Mindanao, 0—36 M.
394. E. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M.
Type. 404. B. Stat. 257. Kei Is., 0—52 M.

British Museum (previously undetermined): —

Darros Id., Amirante Is., Indian Ocean, 22 faths, ("Alert") 82. 10. 18. 125—130 (two slides).
Seychelle Is., 86. 10. 22. 21 (two slides).

Cambridge, Mus. Zool.: —

Singapore, 2. F. P. Bedford, Reg. Nov. 11, 1899.
BM Japan, 5 AP. A. Owston, Reg. June 23, 1902.
Japan, from rooting spicules of *Euplectella marshalli*, Prof. K. Mitsukuri, Reg. Sept. 23, 1896.

1) Named after the late G. M. R. Levinsen, partly in recognition of the value of his work on the Polyzoa, and partly because the present species seems to have been indicated by him.

Encrusting, brown in colour. Zooecia large, but varying in size and shape, not always in distinct longitudinal rows. Frontal membrane thick, the ordinary opercula small. Cryptocyst extensive, at some distance beneath the much raised margins, imperforate, tuberculate, the proximal part strongly developed; produced into a median process, convex on its frontal side, but not forming a complete tube, varying in length, ending freely distally, provided with spinules on its lateral edges, occasionally wanting (in some of the zooecia of a colony). Lateral cryptocyst well developed, produced inwards, on each side, into a triangular process, near the proximal end of the operculum. Oral shelf not present. Opesia strongly trifoliate, with elongate, incomplete opesiules extending along the sides of the median process. Fertile zooecia with an operculum closing the ovicell and about twice the diameter of the ordinary opercula; the ovicell extremely large, entozooecial; the entooecium covered by the tuberculate cryptocyst of the succeeding zooecium, in which the median process is reduced in size. Septula about 3 in the distal part of each lateral wall and about 4 in the terminal wall.

The Eocene *Membranipora squamosa*, described by MEUNIER and PERGENS [1]), should be placed in *Caleschara*, as here understood. It differs from the specimens under consideration in the form of the oral arch of the ordinary zooecia and by having the tubercles of the cryptocyst in distinct longitudinal rows; while it is not known to possess ovicells.

C. levinseni is distinguished from *C. denticulata* by the absence of unions between the median process and the lateral cryptocyst. *C. denticulata* and *C. parva* have ovicells of the same kind as those of *C. levinseni*, justifying the reference of the three species to the same genus. The ovicell is more complicated than that shown in text-fig. 1 *A*. (p. 202). It is covered in the ordinary way by the frontal membrane of the succeeding zooecium, but the entooecium becomes overlaid by the cryptocyst of that zooecium, developed beneath the frontal membrane.

The nature of the ovicell has been verified by finding it to contain an embryo. The parietal muscles are differentiated into a pair of strong muscles inserted into the frontal membrane not far from the proximal corners of the operculum and doubtless serving to open that structure, as well as to depress the membrane; and into a pair of strong depressors, passing through the proximal corners of the opesiules. The Japanese specimens and those from the Seychelles have a strong umbo at the proximal end of the zooecium, or a pair of these structures. A similar large umbo was described by HINCKS (1881, AMNH, 5, VII, p. 152) in *C. denticulata*.

7. **Crassimarginatella** Canu.

Crassimarginatella Canu, 1900, BSGF, 3, XXVIII, p. 369.
Oochilina Norman, 1903, AMNH, 7, XI, p. 595. With the same genotype.
Grammella, CANU, 1917, BSGF, 4, XVI, p. 131. With the same genotype.
Grammella, CANU and BASSLER (*pars*), 1920, USNMB, 106, pp. 84, 130).
"*Membranipora crassimarginata* group" (*pars*), WATERS, 1898, JLS, XXVI, pp. 661, 668.

Genotype, selected by the author, *Membranipora crassimarginata* Hincks, 1880, AMNH, 5, VI, p. 71.

Zooecia with frontal membrane occupying practically the entire front, the gymnocyst slightly developed or vestigial. Cryptocyst narrow. Spines wanting or vestigial. Avicularia

1) MEUNIER, A. and PERGENS, E., 1886, "Bry. Syst. Montien" (Louvain), p. 9, Pl. III, figs a, b. Belgium.

vicarious, with rounded mandible, the calcareous bar complete or incomplete. Ovicells hyperstomial or vestigial. (Pore-chambers wanting, CANU and BASSLER).

CANU, in 1917, unnecessarily introduced *Grammella*, on the ground that *Crassimarginatella*, which he had proposed as a subgenus of *Membranipora*, was not sufficiently defined at the time. The genus is of interest in possessing typical vicarious avicularia. *Valdemunitella* Canu (1900, *op. cit.*, p. 369) seems to be at least closely allied to it. Its genotype is *Membranipora valdemunita* Hincks 1885, AMNH, 5, XV, p. 248), a species in which the gymnocyst is umbonate and more developed than in *C. crassimarginata*, and the ovicell is larger, with two pyriform, membranous fenestrae, converging distally, on the frontal surface.

1. *Crassimarginatella spatulifera* [1]) n. sp. (Pl. XIV, figs 2, 3).

(?) *Membranipora crassimarginata.*, var. *incrustans* (*pars*) Busk, 1884, Chall., p. 63, Pl. XV, figs 5, 5*a*. Nightingale Id., Tristan da Cunha, 110—150 faths.
nec *Membranipora incrustans* Waters, 1898, JLS, XXVI, p. 686, Pl. XLVII, fig. 13.
nec *Membranipora watersi* Kluge, 1914, BDSE, p. 659.

249. E. Stat. 310. Sumbawa, E., 73 M.

British Museum: —

(?) *Membranipora crassimarginata*, var. *incrustans* Busk, Nightingale Id., 87. 12. 9. 312 (type) and 99. 7. 1. 1003.

Encrusting. Zooecia robust, inconstant in shape, sometimes obscurely hexagonal; separated by narrow grooves, which expand into a triangular space at the junction of three zooecia, where a gymnocyst is just indicated. Frontal membrane occupying the entire front. Opesia usually oval, surrounded by a shelving, tuberculate cryptocyst, most developed proximally. Avicularia vicarious, rare, at least as large as the zooecia, the rostrum occupying about four fifths of the length, broadly spatulate and widest distally, the oral shelf much developed; condyles strong, the proximal opesia very short. Mandible filling the rostrum, with a pair of projections proximally, articulating with the condyles. Ovicell vestigial. A single, sharply outlined rosette-plate in the middle of the terminal wall.

In one of the specimens the basal wall is produced into long and strong, calcareous, leg-like processes for attachment, usually given off from the middle line, in a longitudinal row of two or three. This was probably the result of growing on an irregular surface, and the processes are not present in a second specimen. The vestigial ovicells are seen in fig. 2, and they occupy only a small proportion of the width of the zooecium. Each consists of a transverse, two-layered structure, representing the two layers of a typical hyperstomial ovicell. Canada balsam preparations show that some of the zooecia thus provided contain a large embryo, in an ovisac, at the distal end. The distal rosette-plate is probably, but not certainly, multiporous; and there appears to be a single rosette-plate on each lateral wall, opening from about the middle of one zooecium into the proximal end of its lateral neighbour.

The present species differs from *C. crassimarginata* in the direction and shape of its

1) In allusion to the form of the mandible.

avicularia, in the absence of a complete calcareous bar in these structures, and in having vestigial ovicells. Typical hyperstomial ovicells occur in *C. crassimarginata*, as described by HINCKS, in *C. crassimarginata*, var. *japonica* Ortmann (1889, ANG, LVI, I, p. 28) and in *C. kumatae* (*Membranipora*) Okada (1923, AZJ, X, p. 223). In a later paper (1891, AMNH, 6, VIII, p. 86) HINCKS pointed out, I think rightly, that BUSK's *M. crassimarginata*, of the Challenger Report, is not the same species. BUSK had recognized the following two varieties: —

(a) var. *erecta*. The figured specimen (Brit. Mus. 87. 12. 9. 309) is from Stat. 162, Bass Straits; and WATERS (1898, JLS, XXVI, p. 689) identifies it with *Biflustra perfragilis* MacGillivray (1881, PZV, VI, p. 27), which was described from the same locality. He states that it is not obvious why MACGILLIVRAY had rejected his own earlier name (1869, PRSV, IX, p. 138). *B. fragilis*; but it may be presumed that this author had discovered that is was antedated by *Biflustra fragilis* D'Orbigny (1852, PFTC, p. 255).

(b) var. *incrustans*. On p. 686 of the same paper WATERS introduced *M. incrustans*, nom. nov., for. var. *incrustans* (*pars*) Busk. The form he figured (Pl. XLVII, fig. 13) has relatively small, triangular avicularia, differing widely from the large, spatulate avicularia figured by BUSK. KLUGE (1914) pointed this out; and, on the assumption that *incrustans* should be used for a species agreeing with BUSK's figure, he rejected WATERS' name, which he replaced by *M. watersi*. It appears to me, however, that WATERS' name was a valid introduction of a new species, particularly as he limited it to var. *incrustans* (*pars*) Busk. It must accordingly be used in the sense in which he proposed it, and it is not available for BUSK's figured variety when promoted to specific rank.

The Siboga specimens here described seem to agree in essential respects with var. *incrustans*, as understood by BUSK. The British Museum Collection includes two Challenger slides, from Nightingale Id. 87. 12. 9. 312 is the type, and I have been able to ascertain that the distal wall has a single, sharply defined rosette-plate, and that it agrees with the Siboga material also in the characters of the avicularia. The grooves between the apertures of the zooecia are wider than in the Siboga specimens, though hardly so wide as would be inferred from BUSK's figure; and the gymnocyst is accordingly larger. Vestigial ovicells are perhaps present. In the second specimen (99. 7. 1. 1003) the grooves are wider, as in BUSK's figure, with the result that a certain amount of lateral and proximal gymnocyst is visible.

8. **Allantopora** Lang.

Allantopora Lang, 1914, GM, 6, I, p. 436; — 1915, GM, 6, II, p. 503.

Genotype, selected by the author, *Hippothoa irregularis* Gabb and Horn, 1860.

LANG has instituted several genera for uniserial Cretaceous Cheilostomes, but I am not convinced that they are all required. As the species described below agrees closely with *A. irregularis* (Gabb and Horn), as understood by LANG (1914, p. 437, Pl. XXXIV, fig. 1), except in possessing ovicells, I refer it provisionally to his genus.

Allantopora differs from the other uniserial genera described by LANG (see his table, 1915, p. 503) principally in having no avicularia, in the "beaded" margin (*i. e.*, furnished with spines) of the opesia, and in the absence of a distinct cryptocyst.

1. *Allantopora translucens* n. sp. (Pl. XIV, fig. 5).

566. D. Stat. 204. Between Wowoni and Buton, S. E. Celebes, 75—94 M. On a stone, of very irregular surface, resulting in considerable irregularity in the arrangement and form of the zooecia.

Zooecia uniserial, pyriform, moderately narrow proximally, with lateral buds given off near the distal end. Gymnocyst longer than the opesia, its walls specially delicate and hyaline. Opesia oval, its margin thin and bearing about 10 overarching spines; cryptocyst wanting. Ovicell hyperstomial, of the same texture as the zooecia, its frontal surface only partially covered by the ectooecium, the edge of which appears as a curved line.

In the shape of the zooecia and in the position of the spines this species resembles *Electra*, from which it is distinguished by the possession of ovicells, a feature I consider of fundamental importance. It might have been referred to *Pyripora* D'Orbigny (1849, Rev. Mag. Zool., 2, I, p. 499), the genotype of which is *Criserpia pyriformis* Michelin (see Lang, 1915, p. 501); but Michelin gives no indication of either spines or ovicells. Miss Thornely (1912, PIOS, p. 143) mentions ovicells in a specimen from the Indian Ocean, referred by her to *Membranipora pedunculata* Manzoni. The description given by Searles Wood (1844, AMNH, XIII, p. 19) of *Catenaria dentata* from the English Crag appears to indicate a species resembling *A. translucens*, but it is not illustrated by figures. *Brettia pellucida*, var. *gracilis* Nichols (see p. 198) may belong to this genus.

9. **Pyrulella** n. gen.

"*Membranipora corbula* group" (*pars*) Waters, 1898, JLS, XXVI, pp. 661, 665.

Genotype, *Membranipora pyrula* Hincks, 1881, AMNH, 5, VIII, p. 3.

Zooecia with a distinct gymnocyst, which may be reduced. Opesia more or less oval, surrounded by spines; cryptocyst slight or moderate. Avicularia, if present, vicarious. Ovicells hyperstomial. Pore-chambers wanting.

It seems desirable to propose a new generic name for species with the general appearance of *Callopora* Gray (1848, BMRA, pp. 109, 146), but distinguished from that genus by the absence of pore-chambers and of adventitious avicularia, and by the frequent possession of vicarious avicularia. *Pyrulella* has some resemblance to *Hincksina* Norman (1903, AMNH, 7, XI, p. 585), the genotype of which is *Membranipora flustroides* Hincks (1877, AMNH, 4, XX, p. 213; 1880, BMP, p. 151), which is also without pore-chambers and has marginal spines and vicarious avicularia. The principal distinctions between the two genera are the characters of the avicularia and of the ovicells. The avicularia of *Hincksina* are small, the ovicells are inconspicuous and entozooecial (see Levinsen, 1909, MSSB, pp. 58, 126, Pl. I, figs 4 *a—c*; Pl. XXIV, fig. 7), and the gymnocyst is wanting. Levinsen referred *M. flustroides* to *Spiralaria* Busk, and Norman expressed the opinion that it should be placed in the Flustridae.

1. *Pyrulella corbula* (Hincks). (Pl. XIV, fig. 4).

Membranipora corbula Hincks, 1880, AMNH, 5, VI, p. 378, Pl. XVII, fig. 6. Australia.
Membranipora corbula MacGillivray, 1886, PZV, XIII, p. 103, Pl. CXXVII, fig. 2. Victoria.

Membranipora corbula Waters, 1887, AMNH, 5, XX, p. 182. Victoria, New South Wales; — 1889, AMNH, 6, IV, p. 2. New Zealand; — 1898, JLS, XXVI, pp. 677, 658—661, 665, 689, Pl. XLVIII, fig. 20.

(?) *Membranipora corbula* Thornely, 1924, AAE, p. 8. Auckland Is.

Cambridge, Mus. Zool.: —

BM Torres Straits, 129. 187, A. C. HADDON, Reg. Feb. 24, 1898.
Japan, from rooting spicules of *Euplectella marshalli*, Prof. K. MITSUKURI, Reg. Sept. 23, 1896.
BM Japan, 2 W, A. OWSTON, Reg. June 23, 1902.

Encrusting. Zooecia of moderate size, quincuncial, separated by grooves, the frontal membrane not covering the entire surface, a gymnocyst exposed proximally and to a slighter extent laterally. Opesia usually oval, surrounded by about 3—5 pairs of marginal spines, which spring from the outer border of the cryptocyst; the region of the orifice with about 4—5 oral spines. Cryptocyst well developed proximally and laterally, finely tuberculate. Adventitious avicularia wanting. Vicarious avicularia rare, proximally resembling zooecia, but oral arch larger, prominent and smooth; mandible semicircular, with basal sclerite and a curved main sclerite, formed by the union of two halves. Ovicell globose, closed by the operculum, usually with a rib on each side, converging to a median umbo situated at the distal end; the thickening bars occasionally forming a rounded curve without an umbo. A single distal rosette-plate.

The above specimens are doubtfully referred to the species described by HINCKS and MACGILLIVRAY. They correspond closely with *M. corbula* Waters (1898, Pl. XLVIII, fig. 20), who shows a vicarious avicularium, and a ribbed, umbonate ovicell. On p. 659 he states that there is one distal rosette-plate, and on p. 660 he gives the number of the lateral plates as 4. *M. maderensis*, which appears to be closely allied to the present species, is described by him in the same paper (p. 677) as having very similar vicarious avicularia. On pp. 658, 689 he gives useful lists of species possessing these structures.

P. corbula was described by HINCKS and MACGILLIVRAY as having 1 or 2 pairs of strongly enlarged spines at the sides of the orifice; but WATERS (1889) states that the differences between these and the marginal spines is not always marked, and that the ovicell may be umbonate. The Japanese specimens which I refer to this species have somewhat enlarged oral spines, and an ovicell as in the Torres Straits material.

10. **Copidozoum** [1]) n. gen.

Oochilina (*pars*) Norman, 1903, AMNH, 7, XI, p. 595.

Genotype, *Copidozoum planum* (*Membranipora plana* Hincks, 1880, AMNH, 5, VI, p. 81).

Zooecia with greatly reduced gymnocyst, the frontal membrane covering almost the entire frontal surface. Cryptocyst most developed proximally, moderate or extensive. Spines present, absent or vestigial. Avicularia vicarious, numerous, alternating with the zooecia, the rostrum triangular proximally, usually narrow and linear distally, the mandible of corresponding form. Ovicells hyperstomial.

The present genus differs from *Crassimarginatella*, with which some of its species have

1) Κοπίς, a knife, in allusion to the form of the mandible.

been placed, by the form of the avicularia, which are, moreover, more numerous than in that genus. The two genera may have been evolved from the condition represented by the two types of "*B*" zooecia found in the two sections of the genus *Steganoporella*. On this view, the zooecia with opercula having ∧-shaped main sclerites have become the acute vicarious avicularia of *Copidozoum*, and those with ∩-shaped main sclerites have given rise to the rounded vicarious avicularia of *Crassimarginatella*.

The following species, in addition to the genotype, may be referred to *Copidozoum*: —

Membranipora falcata MacGillivray, 1869, PRSV, IX, p. 132; — 1882, PRSV, XVIII, p. 118.
Syn. *M. permunita* Hincks, 1881, AMNH, 5, VII, p. 151.

Membranipora vibraculoides Okada, 1923, AZJ, X, p. 223 (syn. of *M. plana*).

Membranipora tenuirostris Hincks, 1880, AMNH, 5, VI, p. 70.

Membranipora aperta Busk, 1859, FPC, p. 33.

1. *Copidozoum sagittiferum* n. sp. (Pl. XIV, fig. 6).

250. D. Stat. 310. Sumbawa, E., 73 M.

Encrusting. Zooecia robust, quincuncial, large and broad, widest proximally, the edges considerably raised and separated by deep grooves. Oral spines 2, minute, placed distally to the orifice. Cryptocyst a deeply shelving, tuberculate layer, slightly widened proximally. Avicularia regularly alternating with the zooecia, oval, the rostrum much shorter than the mandible, constricted at its middle. Mandible long, the distal two-thirds acicular, strongly compressed, with a sharp, knife-like cutting edge, and bearing two strong, recurved barbs shortly before joining the triangular proximal portion. Ovicell prominent, wider than long, most prominent at the oral arch, bearing a slight median mucro more distally; not closed by the operculum, which is at some distance from it. Rosette-plates multiporous, apparently one or two in the distal half of each lateral wall.

C. sagittiferum differs from other species in its short avicularian rostrum, and in the presence of barbs on the mandible. *C. falcata* has a much more extensively developed proximal cryptocyst.

The avicularia are vicarious, although some of them might, at first sight, appear to be situated on an asymmetrical gymnocyst produced by one of the proximal corners of a zooecium. The large, strongly recurved barbs of the mandible, to which the trivial name refers, are a striking feature. The shape of the rostrum is naturally correlated with the form of the mandible, the proximal portion corresponding with the triangular base of that structure, and the lateral incurved portions occurring between this part and the distal widening, which receives the barbs when the mandible is closed. When open the mandible usually lies in a groove between two zooecia.

11. Ellisina Norman.

Ellisina Norman, 1903, AMNH, 7, XI, p. 596.
Ellisina Canu and Bassler, 1917, USNMB, 96, p. 19; — 1920, USNMB, 106, pp. 84, 125.

Genotype, *Membranipora levata* Hincks, 1882, AMNH, 5, X, pp. 249, 467.

As originally defined by Norman, *Ellisina* differs from *Oochilina* (i. e., *Crassimarginatella*) in having avicularia of a different type, situated on the proximal gymnocyst. Ovicell well developed. Pore-chambers large, the lateral ones projecting outside the zooecia. The characters of the genus

are thus not fully stated, and it may be added that the frontal membrane is extensive, the opesia oval and the cryptocyst slight. Spines are at most vestigial.

Canu and Bassler stated (1917) that the genotype was *M. laxata* Hincks, a species which I do not recognize; but this appears to have been a mistake, as it does not re-appear in their later work, where the genotype is given correctly.

The species described below appears to be referable to *Ellisina*, in which Norman included *M. albida* Hincks, a species allied to it.

1. *Ellisina curvirostris* (Hincks). (Pl. XIV, fig. 7).

Membranipora curvirostris Hincks, 1862, AMNH, 3, IX, p. 29, Pl. VII, fig. 4; — 1880, BMP, p. 153, Pl. XX, figs 5, 6. Cornwall.
Membranipora curvirostris Ridley, 1881, PZS, p. 46. Brazil.
Membranipora curvirostris Waters, 1898, JLS, XXVI, pp. 684, 668, Pl. XLVII, fig. 2. Naples; — 1918, JLS, XXXIV, p. 9. Cape Verde Is.
Membranipora curvirostris Robertson, 1921, BBB, p. 46. Ganjam Coast (S. W. of Calcutta).
Callopora curvirostris Canu and Bassler, 1925, MSNM, X, p. 14. Morocco (Atlantic).

Cambridge, Mus. Zool: —

BM Singapore, 6 faths, Dr R. Hanitsch, Reg. Apr. 10, 1900.
BM Adelaide. Dr J. C. Verco, Reg. Mar. 16, 1904 (2 slides).

Encrusting. Zooecia very delicate, shallow, in not very distinct longitudinal lines, separated by grooves, the gymnocyst wanting or small. Frontal membrane oval, 2 small spines, one on each side of the orifice, at the proximal corners of the ovicells in fertile zooecia. Cryptocyst narrow. Avicularia at the proximal end of a kenozooecium (or vicarious?), the rostrum asymmetrical, considerably curved and denticulate at the frontal edge. Mandible triangular proximally, acicular distally. Ovicell hyperstomial, prominent, globose, its surface frosted, usually with a slight mucro in the middle line of the oral arch; not closed by the operculum. Pore-chambers?

The diagnosis is drawn up mainly from a single colony encrusting a piece of coal dredged at Singapore. I have not been able to examine the communication-pores, but Waters (1898, p. 668) states that the rosette-plates are 8 lateral and 1 distal.

The previous records of this species, originally described from the British coast, indicate a wide distribution, from Brazil, across the Atlantic, and in the neighbourhood of Calcutta. The avicularium is perhaps at the proximal end of a kenozooecium; or the supposed kenozooecium, the existence of which has been specially emphasized by Hincks (1880) and Waters (1898), may prove to be part of the avicularium itself. The evidence seems to me in favour of the former view. Hincks (1880, p. 154) referred to "a closely allied form from Singapore", and this is doubtless the species described by him in the same year (1880, AMNH, 5, VI, p. 81) as *M. albida*, which appears to be distinguished from *E. curvirostris* by its shallow ovicell and by the avicularia not being obviously placed on kenozooecia.

12. **Chaperia** Jullien.

Chaperia Jullien, 1881, BSZF, V, pp. 163, 164.
Chaperia Levinsen, 1909, MSSB, p. 115.
Chaperia Canu and Bassler, 1923, USNMB, 125, p. 49.
"*Chaperia* group" Waters, 1898, JLS, XXVI, pp. 660, 664.

Genotype, *C. australis* Jullien, nom. nov. for *Membranipora spinosa* Busk (1879, PTRS, CLXVIII, p. 195), which there is reason for regarding as a synonym of *Flustra acanthina* Lamx., in Quoy and Gaimard.

Distinguished mainly by the presence of two calcareous laminae arising from the lateral walls, at their distal end, and projecting towards the opesia. As shown by JULLIEN (1888, CH, p. 61, Pl. XV, fig. 4 and explanation of Plate), these form partial cavities, with the lateral walls, for the origin of the opercular occlusors; and I term them the occlusor-laminae. Oral spines and cryptocyst well developed. Hyperstomial ovicells and avicularia usually present; both wanting in the type-species. (Rosette-plates multiporous, LEVINSEN).

CANU and BASSLER (1923, p. 51) have expressed a doubt whether the presence of occlusor-laminae is sufficient to characterise a Family (Chaperidae, JULLIEN, 1888). This doubt may be well founded, in view of the fact that a certain number of the species are not known to possess either ovicells or avicularia, structures which are well developed in other species referred to *Chaperia* (see KLUGE, 1914, BDSE, pp. 666—677). If it should be necessary to subdivide the genus, *Chaperia* would have to be restricted to *C. acanthina* and its allies.

1. *Chaperia acanthina* (Lamx.). (Pl. XIV, figs 9, 10).

Flustra acanthina, "Flustre épineuse" Lamouroux, in Quoy and Gaimard, 1825. Zool. Voy. Uranie et Phys., p. 605, Pl. LXXXIX, figs 1, 2. Falkland Is. (For date, see AMNH, 7, VII, 1901, p. 392).
Cellepora acanthina D'Orbigny, 1852, PFTC, p. 403.
Membranipora spinosa Busk, 1879, PTRS, CLXVIII, p. 195, Pl. X, fig. 3. Kerguelen.
nec *Membranipora spinosa* D'Orbigny, 1839—1846, VAM, p. 16.
nec *Membranipora spinosa* Busk, 1884, Chall., p. 64.
Chaperia australis Jullien, 1881, BSZF, VI, p. 163. Cape of Good Hope.
Membranipora spinosa Hincks, 1881, AMNH, 5, VII, p. 150. Arabian Sea.
Membranipora spinosa MacGillivray, 1882, PRSV, XVIII, pp. 117, 120, Plate, fig. 12. Victoria; — 1886, PZV, XIII, p. 107, Pl. 127, fig. 8.
Membranipora spinosa Waters, 1887, AMNH, 5, XX, p. 182. New Zealand, Queensland, New South Wales.
Lepralia acanthina Kirkpatrick, 1890, TS, pp. 612, 617, Pl. XVI, fig. 6 (operculum). Torres Straits.
Chaperia (Flustra) spinosa Jullien, 1888, CH, pp. 61, 62, Pl. V, figs. 3—5, Pl. XV, fig. 4.
Chaperia acanthina Waters, 1898, JLS, XXVI, pp. 656, 659, 664, Pl. XLVII, fig. 10 (operculum).
Chaperia acanthina Calvet, 1904, HMS, p. 11 (see his synonymy).
Chaperia acanthina Kluge, 1914, BDSE, p. 675, text-fig. 46. Kerguelen.
Chaperia acanthina Marcus, 1921, BAC, p. 88 (see his synonymy).

11.A. Stat. 33. Pidjot Bay, Lombok, 0—22 M. On a Nullipore.
472.L. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M. On a Nullipore.
278.C. Stat. 250. Kur Id., Kei Is., 0—45 M. On a Nullipore.

Cambridge, Mus. Zool.: —

Torres Straits, 49. A. C. HADDON, Reg. Febr. 24, 1898.
BM Japan, 5. R. Off Tokyo, 40 faths, A. OWSTON, Reg. June 23, 1902.

British Museum: —

Kerguelen, 99. 7. 1. 1151—1156, Busk Coll.
Natal, 72. 8. 6. 6. and 99. 7. 1. 127, Coll. Bolton.
New Zealand, 99. 5. 1. 647, Hincks Coll. and 99. 7. 1. 1158. 1159, Busk Coll.
Torres Straits, 90. 11. 22. 5, Haddon Coll., described by KIRKPATRICK.

Encrusting. Zooecia quincuncial, broad; opesia generally rather longer than wide, widest proximally, occasionally nearly circular or transversely oval. Proximal cryptocyst varying in length, often much shorter than the opesia, or nearly as long; covered with closely set, rounded tubercles. Occlusor-laminae long, nearly parallel or converging distally. Spines large, jointed at the base, usually 7—10; smaller spines, more distally directed, sometimes occurring on the distal wall. Operculum large, with two well marked submarginal sclerites. Avicularia and ovicells not found.

The material is scanty, but shows a few variations. In the Siboga specimens the spines are usually 8, with no subsidiary spines. These occur in the Torres Straits specimen, where about 6 are found, projecting distally, in a horizontal direction, over the next zooecium. The principal spines are in this case 6; while in the Japanese specimen they are usually 9 or 10. The long occlusor-laminae seem to be a characteristic feature of this species.

C. acanthina appears to have a circumpolar distribution, extending northwards into the Indian Ocean (Hincks) and as far as Japan in the Pacific. From an examination of the specimens in the British Museum I feel justified in giving Kerguelen, New Zealand, Natal and Torres Straits as localities, though I am less confident that all the specimens from Australia belong to the present species. It differs from most species of the genus in the absence of avicularia and ovicells; and it varies in the number of spines and in the extent of the proximal cryptocyst. The original description, by Lamouroux (in Q. and G.), is accompanied by a figure in which 8—9 spines are represented. The mistake made by several authors in recording it as *M. spinosa* probably resulted from the use of the appellation "Flustre épineuse" in the original diagnosis. From Busk's figure (1879) it would be inferred that the spines are 5—6, in specimens from Kerguelen; but a study of his slides shows that 8 occur in some cases, and that the typical number is 6—8. Kluge, however, found 4—5 spines in other specimens from the same locality. I include *M. spinosa* MacGill. in the synonymy on the ground that this author stated (1886) that the common basis supporting the spines had been made much too large in his figure. Allowing for this admitted imperfection, *M. spinosa* MacGill. appears to be probably synonymous with *C. acanthina*, which Marcus (1921, BAC, p. 88) regards as correct, including also *M. ciliata* of the same author.

Jullien (1888, CH, Pl. V, fig. 3) figured the ancestrula, which resembles the ordinary zooecia in general characters, including the possession of occlusor-laminae, but the bases of 5 marginal spines are indicated, in addition to 7 on the oral arch. The ancestrula has also been described by Waters (1924, AMNH, 9, XIV, pp. 600, 607, Pl. XIX, fig. 4).

2. *Chaperia cervicornis* (Busk). (Pl. XIV, fig. 8).

Membranipora cervicornis Busk, 1854, BMC, p. 60, Pl. C, fig. 3. Tasmania.
Membranipora cervicornis MacGillivray, 1860, TPIV, IV, p. 165; — 1879, PZV, III, p. 32, Pl. XXV, figs 8—8*c*. Victoria.
Membranipora cervicornis Hincks, 1881, AMNH, 5, VII, p. 153, Pl. VIII, fig. 1. Victoria.
Membranipora cervicornis Waters, 1888, Chall., p. 10; — 1889, AMNH, 6, IV, p. 3. New South Wales.
Membranipora cervicornis Robertson, 1921, BBB, p. 46. Palk Straits.
nec *Membranipora cervicornis* Haswell, 1880, PLSNSW, p. 38, = *M. haswellii* Hincks (see under *Hiantopora intermedia*, p. 237).

Amphiblestrum cervicorne Busk, 1884, Chall., p. 66. Bass Straits.
nec *Amphiblestrum cervicorne* Thornely, 1895, PGM, p. 110; corrected by her, 1906, PGMC, p. 449, to *A. radicifera*, var. *intermedia*.
Membranipora (Amphiblestrum) cervicornis Kirkpatrick, 1890, TS, p. 612. Torres Straits.
Chaperia cervicornis Waters, 1898, JLS, XXVI, pp. 656, 659, 662, 664.

Cambridge, Mus. Zool.: —

Torres Straits, 139, 160, A. C. HADDON, Reg. Febr. 24, 1898.

British Museum: —

Torres Straits, 90. 3. 24. 80, A. C. HADDON.
Victoria, 97. 5. 1. 550, J. BRACEBRIDGE WILSON (and others).

Encrusting. Zooecia quincuncial, not so broad as in the preceding species. Opesia generally longer than wide, sometimes as wide as long, or wider; its distal margin slightly curved in ordinary zooecia, straight in those bearing an ovicell, wider distally than proximally. Cryptocyst nearly smooth, with small, inconspicuous, rounded tubercles; proximally varying in extent, shorter than the opesia. Occlusor-laminae short, oblique, converging distally. Spines, on the distal margin, 4, bifurcating one or twice; the inner ones more slender than the outer, and adnate to the ovicell in fertile zooecia; the outer ones free, originating at the ends of the transverse lamina bounding the ovicell proximally. The inner spines bifurcate sub-horizontally, nearly in the plane of the distal wall of the zooecium, the outer spines branching in a plane at right angles to that of the others, and with their main distal limb tending to assume a horizontal position. Smaller, horizontal spines, branching like the others, on the distal wall of the marginal zooecia at least. Operculum much more delicate than in *C. acanthina*. Ovicells large, their distal margin much raised, the whole of the frontal surface flat and membranous. In the cleaned condition they appear strongly cucullate, the frontal wall deficient and the distal wall formed of two well separated calcareous layers. Cavity of the ovicell divided from that of the zooecium by the high, calcareous, distal wall, the frontal edge of which is straight and transverse. The cavity is very deep on the distal side of this wall, its floor being thus distant from the projecting edge of the cucullate ovicell. Avicularia not found.

C. cervicornis was described by BUSK in 1854, but the locality was then recorded as unknown. The type-slide (54. 11. 15. 218) in the British Museum is marked Tasmania, so that it may be inferred that BUSK obtained new information after the publication of his Catalogue. The correctness of the locality on this slide is confirmed by the fact that Victorian specimens in the British Museum, and particularly 99. 7. 1. 996 (BUSK Coll.) and 97. 5. 1. 548 (J. BRACEBRIDGE WILSON Coll.), agree closely with the type-specimen. BUSK and HINCKS (1881, p. 154) stated that the ovicell is crowned with a small avicularium.

The Torres Straits material shows no avicularia, and although possibly indicating a specific difference, I think this is probably not the case, since in the form of the opesia and of the occlusor-laminae, as well as in the cucullate ovicell, these specimens agree closely with the type. WATERS (1888) states that the laminae are not very distinct, but this may be explained by the fact that they are sometimes concealed by the distal cryptocyst. In the typical condition the main branches of the second pair of spines are robust and lie horizontally, but they are not so large in the specimens from Torres Straits. In some instances (Brit. Mus., 99. 5. 1. 542,

Victoria, HINCKS Coll.) the ovicells have the front wall better developed than usual, and the two layers are separated, at the most prominent part, by a triangular, membranous region, as figured by HINCKS (1881, AMNH, 5, VII, p. 154, P. X, fig. 3*a*), in a variety of the present species. If the differences here mentioned are not to be regarded as specific, the evidence of specimens in the British Museum shows that the species is common in South Australia and New Zealand.

13. **Antropora** Norman.

Antropora Norman, 1903, AMNH, 7, XII, p. 87.
Antropora Canu and Bassler, 1920, USNMB, 106, pp. 84, 175.
Genotype, *Membranipora granulifera* Hincks, 1880, AMNH, 5, VI, p. 72.
nec *Antropora* Lang, 1916, AMNH, 8, XVIII, p. 91; replaced by *Coelopora* Lang, 1917, GM, 6, IV, p. 169.

Frontal membrane occupying almost the entire front, gymnocyst reduced or vestigial. Cryptocyst well developed, especially proximally, extending round the entire opesia, which is typically depressed, owing to its steep descent. Adventitious avicularia paired, sometimes arranged so as to face one another on the distal border of the preceding zooecium. Vicarious avicularia, with rounded mandibles, occasionally present. Ovicells vestigial, entozooecial. (Pore-chambers present, NORMAN).

1. *Antropora granulifera* (Hincks). (Pl. XIV, figs 11—14).

Membranipora granulifera Hincks, 1880, AMNH, 5, VI, p. 72, Pl. IX, fig. 4. Madeira.
Membranipora granulifera Waters, 1898, JLS, XXVI, pp. 659, 660, 668.
Membranipora granulifera Calvet, 1907, BTT, p. 389. Cape Verde Is.
Membranipora granulifera Thornely, 1912, PIOS, p. 143. Indian Ocean.
Antropora granulifera Norman, 1903, AMNH, 7, XII, p. 87, Pl. VIII, fig. 4. Madeira; — 1909, JLS, XXX, p. 288.
Amphiblestrum granuliferum Thornely, 1905, PGM, p. 110. Ceylon.

409. E. Stat. 60, 303. Haingsisi, Samau Id., W. Timor, 0—36 M.
388. L.) Stat. 81. Borneo Bank, Strait of Makassar, 0—34 M.
459. Q.)
393. B. Stat. 133. Lirung, Talaut Is., S. of Mindanao, 0—36 M.
404. C. Stat. 257. Kei Is., 0—52 M.
412. E. Stat. 310. Sumbawa, E., 73 M.

Cambridge, Mus. Zool.: —

BM *Amphiblestrum granuliferum* Ceylon, 15. L. R. THORNELY, Reg. Apr. 25, 1906.

BM Japan, 5. N, A. OWSTON, Reg. June 23, 1902.
BM Japan, T. MITZOBUCHI, Reg. Feb. 1, 1901.

Encrusting. Zooecia very variable in size, small in the central part of a colony, increasing towards the periphery, where they are very large; quincuncial, the arrangement in longitudinal rows often indistinct; separated by shallow grooves; variable in shape, the frontal membrane covering the entire surface except the small gymnocyst bearing the avicularia. Spines wanting. Opesia more or less oval, or wider proximally. Cryptocyst tuberculate, descending steeply to the opesia, especially laterally, narrow in the young state, becoming more extensive, proximally,

in the peripheral zooecia, where the tuberculations are larger; the free edge of its proximal portion usually straight and transverse, sometimes oblique and asymmetrical. Adventitious avicularia numerous, borne on the proximal corners of the zooecia, but commonly appearing to belong to the preceding zooecia. Rostrum narrow and very acute, directed distally or transversely inwards; the mandible narrow, acicular. Ovicells vestigial, the fertile zooecium having its distal edge more raised than the ordinary zooecia, the ovicell partly covered by the cryptocyst of the succeeding zooecium, as in *Caleschara*. Vicarious avicularia rare, the rostrum less than half the length of the zooecium, rounded and raised distally, with lateral walls not incurved, converging towards the distal end; opesia continuous and reaching the distal end, without oral shelf, a pair of small condyles for the articulation of the mandible, which has a strong basal sclerite, giving off a sclerite distally from each of its ends; the distal margin with three teeth. Pore-chambers apparently present.

The specimens referred to this species vary considerably. In 393. B, 404. C and Miss Thornely's specimen from Ceylon, they agree with Hincks' description of *A. granulifera*, the zooecia being very large, with a strongly developed, tuberculate cryptocyst; the avicularia lying transversely across the distal margin of the zooecium, with their rostra directed towards one another. They have been described as distal in relation to the zooecia, but I think that they are proximal avicularia belonging to the succeeding zooecium or zooecia. The zooecia shown in fig. 11 (393. B) are peripheral members of a colony in which the central zooecia are much smaller, with smaller opercula, hardly more than half the diameter of those of the largest zooecia, although all the avicularia have the same transverse position. In 459. Q (fig. 13) the avicularia vary in position, some being paired and transverse, especially in the more peripheral zooecia, while others occur at the side of the opesia, the rostra having a distal direction. 388. L (fig. 14) is at first sight entirely different from 393. B (fig. 11), but I believe it to belong to the same species. It appears to consist of zooecia of a young type, which have regenerated from part of the surface of an old colony, mostly composed of dead zooecia, with a distinct resemblance to fig. 11, though with avicularia less regularly arranged. In this young part the avicularia have a longitudinal direction, and they have no special connexion with the distal ends of zooecia. At the left of the figure is seen one of the vicarious avicularia indicated in the diagnosis. 412. E, also a colony of young type, has two of these vicarious avicularia, the mandible of one of them being represented in fig. 12. 409. E, and the Japanese specimens are intermediate between the two extremes. These facts appear to indicate that the colony commences with small zooecia having longitudinal, small avicularia and a slightly developed cryptocyst. The peripheral part is formed of much larger zooecia, in which the avicularia take up a position on the distal border of a zooecium, with their rostra directed transversely towards one another.

The rosette-plates appear to be 2 terminal and 3 in the distal half of each lateral wall and I think that pore-chambers are present. The evidence on these points is not conclusive.

Another species probably referable to this genus, and with two avicularia closely related with the distal margin of a zooecium, is *Membranipora nigrans* Hincks (1882, AMNH, 5, X, pp. 248, 467). Large avicularia occur in this species, in addition to the commoner adventitious kind, of which they may be an enlarged form. *M. pura* Hincks (1880, AMNH, 5, VI, p. 83) seems also to belong to *Antropora*.

2. *Antropora marginella* (Hincks). (Pl. XIV, fig. 15).

Membranipora marginella Hincks, 1884, AMNH, 5, XIII, p. 358, Pl. XIII, fig. 1. Mergui, Burma; — 1887, JLS, XXI, p. 130; — 1893, AMNH, 6, XI, p. 181.
Membranipora marginata Waters, 1898, JLS, XXVI, pp. 658, 669.
Amphiblestrum marginella Thornely, 1905, PGM, p. 110. Ceylon.

388. I. } Stat. 81. Borneo Bank, Strait of Makassar, 0—34 M.
459. P. }
400. D. Stat. 164. W. of N. end of New Guinea, 32 M.

Cambridge, Mus. Zool.: —

BM Torres Straits, 56, 70. A. C. Haddon, Reg. Feb. 24, 1898.
Malay Peninsula, W. W. Skeat, Reg. Nov. 30, 1899.

Encrusting. Zooecia variable in form, shallow, in distinct longitudinal lines, quincuncial, separated by grooves, each expanding into a triangular space at the junction of three zooecia; the gymnocyst not otherwise represented. Frontal membrane oval or broader proximally, spines wanting. Cryptocyst moderate, tuberculate, narrowest distally, more extensively developed in the old state. Vicarious avicularia as large as the zooecia, the rostrum broadly spatulate, about half the length of the avicularium, not tuberculate, its lateral walls considerably raised and projecting inwards towards the middle, the distal edge also raised. Opesia of avicularium continuous, the proximal part often nearly circular or oval, bordered by tuberculate cryptocyst; its junction with the distal part indicated by small condyles. Distal part of the opesia extending almost the entire length of the rostrum, which has a slight oral shelf distally. Mandible rounded, elongate, slightly wider distally, with basal sclerite and main sclerites which are most developed proximally. Small avicularia, with short, rounded mandibles, also without a calcareous bar, plentifully developed on the proximal corners of the zooecia, one occurring in each of the triangular expansions of the grooves between them. Ovicells small, usually not prominent.

The rosette-plates appear to be about 3 in the distal half of each lateral wall, but the evidence is not certain. The vicarious avicularia are considerably larger than those described by Hincks (1884), and they have not been found in all the specimens. The ovicells are usually entozooecial, but a discrepancy occurs in Torres Straits 56. While entozooecial ovicells seem to be represented in this specimen, several are more prominent, hyperstomial, and with a distinct but low median keel. This perhaps indicates that the occurrence of entozooecial ovicells in *Antropora* is secondary, and is due to reversion from a hyperstomial condition.

I do not think that pore-chambers are present, and if they are absent this species does not fall within Norman's definition of *Antropora*. In general characters it agrees, however, with what I have described above as the young state of *A. granulifera*, and more particularly in the occurrence of vicarious, as well as of adventitious avicularia; — a very unusual combination. It differs from that species in the larger vicarious avicularia, in the smaller cryptocyst, and in the short adventitious avicularia, which have a rounded mandible.

A. marginella might possibly have been referred to *Odontionella* Canu and Bassler (1917, USNMB, 96, p. 12; — 1920, USNMB, 106, p. 256; — 1923, USNMB, 125, p. 64). As originally introduced, the genotype was *Membranipora hians* Hincks (1885, AMNH, 5, XV, p. 248); and the absence of pore-chambers was included in the diagnosis. In their two later memoirs

Canu and Bassler included a second genotype, *M. occultata*[1]) Waters (1887, QJGS, XLIII, p. 48), a species which does not seem to be congeneric with their first selection. This procedure may be disregarded as contrary to the accepted Rules of Nomenclature. *Unicellaria* must be defined by characters which are found in *U. hians*, and among them is a peculiar distal prolongation of the operculum, which does not occur in the present species or in *M. granulifera*.

14. Hiantopora MacGill.

Hiantopora MacGillivray, 1887, PRSV, XXIII, p. 208.
Hiantopora Levinsen, 1909, MSSB, p. 111.
Tremopora Ortmann, 1889, ANG, LVI, 1, pp. 12, 29.
Membrostega Jullien and Calvet, 1903, BCH, p. 62.
Membranipora, Amphiblestrum, Beania and *Cribrilina* (partim), auctt.
Monotypical. Genotype, *Lepralia ferox* MacGillivray, 1869, PRSV, IX, p. 132.

Hiantopora was defined by Levinsen as having zooecia connected by cylindrical processes, each provided with a multiporous rosette-plate; with "free" (hyperstomial) ovicells and sessile avicularia; and with rootlets originating from the basal wall. From the proximal part of the avicularium arises a hollow spine (or two), which as a rule is strongly branched and may cover a larger or smaller part of the frontal membrane.

The connexion of the zooecia by tubes separated by fenestrae is a variable feature, within the limits of a single species of this genus. Even when the zooecia appear to be continuous, vestigial fenestrae can sometimes be found, either as mere depressions visible on the frontal surface or as very small actual fenestrae. The sharply defined, circular rosette-plates, one of which occurs between every zooecium and each of its lateral neighbours, are typical of the genus. The occurrence of these six connecting tubes is strongly reminiscent of *Beania*, as has been suggested by several authors. It may indicate a real affinity to that genus, particularly in view of the highly developed avicularia, which resemble those of *Beania* except in not being pedunculate. The remarkable union of the branches of the lateral spines to form a frontal shield, in *H. intermedia* and *H. ferox*, is a specially interesting fact. It recalls the arrangement in certain Cretaceous Cheilostomes, *Steginopora*, *Disteginopora* and *Ubaghsia*, for which see D'Orbigny (1853, PFTC, p. 497), Jullien (1886, BSZF, XI, pp. 609, 614) and Lang (1922, Cat. Cret. Bry. Brit. Mus., IV, p. 222); with the essential difference that in these fossils a frontal shield of the Cribriline type is present, beneath the "lamina peristomica" of Jullien, from which it is separated by a space (see D'Orbigny, Pl. 721, figs 4, 8, 12). Another genus (recent) in which a tertiary wall has been formed on somewhat similar lines is *Stephanopora* Kirkpatrick (1888, AMNH, 6, I, p. 75).

In the recent condition *Hiantopora* has been recorded most frequently from southern Australia, but it extends as far north as Japan. It has been described as a fossil from various Australian localities, specially by Waters and MacGillivray.

In addition to the species considered in this Report, a number of species have been placed in *Hiantopora* by various authors; namely by Maplestone (1909, PRSV, n. s., XXI, pp. 413, 414),

1) *Membranipora occultata* Robertson (1908, ICNA, p. 262) is a distinct species, the trivial name having been proposed without knowledge of the fact that it was pre-occupied.

from the Gilbert Is., recent; by the same author (1909, RAM, VII, p. 271) from the Tasman Sea, recent; by Canu (1908, AMNBA, XVII, pp. 284, 285; — 1911, ibid., XXI, p. 256), from the Argentine, fossil; and by MacGillivray (1895, TRSV, IV, pp. 61, 62), from Victoria, fossil. In all these cases the reference to *Hiantopora* seems to me very doubtful, and some of them at least can probably be assigned to *Arachnopusia* Jullien (1888, CH, p. 62), a genus which may have very different affinities.

The history of the single species found by the Siboga can hardly be understood without reference to two others, of which I give synonymic lists including the more important papers. Of these, one was described by Kirkpatrick (1890) as *Membranipora radicifera*, var. *intermedia*; so named to indicate its position between *M. radicifera* Hincks and *Hiantopora ferox* MacGillivray. This intermediate position may be admitted, but it seems preferable to regard Kirkpatrick's variety as a species, and to consider the other two distinct. The range of variation is so remarkable, and throws so much light on one of the ways in which a frontal shield has been evolved, that a description of some of the individual specimens is required.

1. *Hiantopora radicifera* (Hincks). (Pl. XXXIV, fig. 4). Not in the Siboga collection.

Membranipora radicifera Hincks, 1881, AMNH, 5, VIII, p. 5, Pl. II, figs 6—6*b*. Bass Straits; — 1887, AMNH, 5, XIX, p. 158; — 1891, AMNH, 6, VIII, p. 175.
Membranipora radicifera Waters, 1882, QJGS, XXXVIII, p. 262, Pl. IX, figs 26, 27. Tertiary, Australia; — 1887, AMNH, 5, XX, p. 85; — 1898, JLS, XXVI, pp. 659, 660, 667.
Membranipora radicifera Kirkpatrick, 1890, TS, p. 616, Pl. XVI, fig. 1. Victoria.
Membranipora radicifera MacGillivray, 1895, TRSV, IV, p. 33, Pl. IV, figs 6, 7. Tertiary, Australia.
Membranipora radicifera Maplestone, 1901, PRSV, n. s., XIII, p. 186, Pl. XXIII, fig. 7. Tertiary, Australia.
Beania radicifera MacGillivray, 1886, PZV, XII, pp. 68, 69, Pl. CXVII, figs 6—8.
Hiantopora radicifera Levinsen, 1909, MSSB, p. 111, Pl. IV, figs 6*a*—6*c*.
nec *Tremopora radicifera* Canu, 1904, Mém. Soc. Géol. France, Paléont. XII, 3, p. 7, Pl. I (IV), fig. 9.

Of this species, which retains a Membraniporine character, the British Museum possesses a long series, from the Busk, Hincks and Bracebridge Wilson Collections, all from Victoria with the exception of 99. 7. 1. 1122, from the Busk Collection, labelled "Port William". This appears to be the place of that name in Stewart Id, New Zealand. The zooecia are either continuous or with indications of fenestrae between connecting processes of the *Beania* type. There is otherwise little variation in the characters, which agree with the figures of Hincks (1881, fig. 6) and Kirkpatrick (fig. 1). The avicularium is unilateral, and the 4 spines are short, the only one which shows any trace of branching being the lateral spine opposite the avicularium, and this is simply and shortly bifurcate. Ovicells, which have been figured by MacGillivray (1886, fig. 6), Levinsen (fig. 6*a*) and Waters (1882, fig. 26, in a fossil), are present in 99. 5. 1. 626 (Hincks Coll.) and in 97. 5. 1. 636, 638 (Bracebridge Wilson Coll.), all from Victoria.

2. *Hiantopora ferox* (MacGill.). Not in the Siboga Collection.

Lepralia ferox MacGillivray, 1869, PRSV, IX, p. 132. — 1879, PZV, IV, p. 34, Pl. XXXVIII, figs 8—8*c*. Victoria.
Cribrilina ferox Hincks, 1881, AMNH, 5, VIII, p. 7. Bass Straits; — 1891, ibid. 6, VIII, p. 175 (placed in *Hiantopora*).

Hiantopora ferox MacGillivray, 1887, PRSV, XXIII, p. 209.
Hiantopora ferox Hincks, 1891, AMNH, 6, VIII, pp. 471, 479.
Membranipora radicifera, var. *ferox* Kirkpatrick, 1890, TS, p. 616, Pl. XVI, fig. 3. Victoria.

Represented by two slides in the British Museum: — 99. 7. 1. 1371 (Busk Coll.) and 97. 5. 1. 620, both marked "Australia". The most noteworthy differences between this and *H. intermedia* are as follows: — The union of the spines forming the frontal shield is more complete than in any of the specimens of that species, so that the shield resembles that of a typical, porous, Lepralioid form. The avicularium, which is unilateral, is usually swollen and is prolonged distally, beyond the rostrum, into a prominent umbo, as represented by MacGillivray (1879, Pl. XXXVIII, figs 8 *b*, *c*). Its mandible is considerably shorter and broader than in *H. intermedia*. Calcareous rootlets appear to be fewer than in that species, but the condition of the material is not favourable for the examination of this point. The distal spines are unbranched and they project freely from the oral arch.

3. *Hiantopora intermedia* (Kirkp.). (Pl. XXXIV, figs 1—3, text-fig. 2).

Membranipora radicifera, var. *intermedia* Kirkpatrick, 1890, TS, pp. 612, 615, Pl. XVI, fig. 2. Torres Straits, 15—20 fath.
Membranipora radicifera, var. *intermedia* Hincks, 1891, AMNH, 6, VIII. pp. 471, 479.
Membranipora radicifera, var. *intermedia* Philipps, 1899, WZR, pp. 440, 443. Loyalty Is.
Membranipora radicifera, var. *intermedia* Thornely, 1907, MPIM, p. 186. Cheduba (Burma); — 1912, PIOS, p. 142. Indian Ocean, 75 fath.
Membranipora intermedia "Kirkpatrick, var." MacGillivray, 1895, TRSV, IV, p. 34, Pl. IV, fig. 8. Torres Straits (recent).
Membranipora intermedia Waters, 1898, JLS, XXVI, p. 681. Waters suggests that this may be *M. haswellii* (see below).
Amphiblestrum cervicorne Thornely, 1905, PGM, p. 110; corrected by her, 1906, PGMC, p. 449, to *Amphiblestrum radicifera*, var. *intermedia*.
Tremopora dendracantha Ortmann, 1889, ANG, LVI, 1, p. 29, Pl. II, fig. 6. Japan, 200 fath.
(?) *Membranipora haswellii* Hincks, 1882, AMNH, 5, X, p. 468 n.; nom. nov. for *M. cervicornis* Haswell, 1880, PQC, p. 38 (nec *M. cervicornis* Busk, 1854, BMC, p. 60).

Waters' identification of this species with *M. haswellii* seems very doubtful, in view of the description given by Haswell.

325. I. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
67. L. Stat. 99. North Ubian, Sulu Archipelago, 16—23 M.
225. A. Stat. 305. Solor Strait, E. of Flores, 113 M.
249. C. Stat. 310. Sumbawa, E., 73 M.

Cambridge, Mus. Zool.: —

BM Loyalty Is. (Miss E. G. Philipps), A. Willey, Reg. Mar. 1, 1898.
BM Adelaide, Dr J. C. Verco, Reg. Mar. 16, 1904.
BM Japan, off Tokyo, 5. S, 28. G, A. Owston, Reg. June 23, 1902.

British Museum: —

Torres Straits (R. Kirkpatrick), A. C. Haddon, 90. 11. 22. 7.

Zoarium unilaminar, attached to the substratum by numerous fine calcareous rootlets (Fig. 2), sometimes bifurcating near their base. Zooecia either continuous or connected with their neighbours by six short processes, separated by fenestrae; the oral end much raised, the lateral

edges less raised, the cryptocyst narrow and smooth, the opesia longitudinally oval. Spines 2 distal and 2 lateral, generally all branched, the lateral pair, or one of them, extensively branched in a horizontal plane. Avicularia intimately related with the lateral spines, developed on the distal side of their principal branches, on one or both sides, the rostrum and mandible asymmetrical and acute, directed distally and curved towards the middle line. Ovicells not found. Rosette-plates 1 terminal, 1—1 lateral, large, sharply defined and round, with numerous pores (fig. 3).

(a) Siboga, 225. A (fig. 1). — Zooecia with connecting processes, separated by fenestrae. Avicularium unilateral. All 4 spines branched, particularly the avicularian spine, the principal branches of which are on the proximal side of the avicularium and are 3 or 4 times bifurcate, the ultimate branches fine and pointed. Some branches of the other lateral spine are similarly developed; and, with those of the opposite side, form the commencement of a horizontal frontal shield, raised far above the frontal membrane. Some of the branches come into contact with one another, but as a rule do not completely fuse, as their limits are easily discernible. The avicularium bears a single branched spine (really a branch of the avicularium-spine complex) on its outer side. In some cases the distal zooecial wall is considerably prolonged beyond its normal level and a number of small branching spines originate from its free edge, or just below it, on the distal side. This indicates a complete fusion of the basal parts of the two distal spines, whose branches come off in a confused way from the end of the fused portion. In the figured specimen the two distal spines are not thus fused, but two of the branches meet one another.

(b) Siboga, 325. I. — Zooecia continuous or with vestigial fenestrae. Avicularia generally unilateral, occasionally paired. Branching of spines much less than in 225. A; the distal pair rather long, suberect and usually unbranched; the lateral spines subequal, with few and short branches, which are nearly always separated by a considerable interval from those of the opposite side. A single conical spine usually present on the outer side of the avicularium, in the place of the branched spine of fig. 1, directed obliquely distally; a recurved or erect, curved spine on the outer side of the base of the mandible.

(c) Siboga, 249. C. — Zooecia continuous, without fenestrae. Avicularia paired or unilateral. Branches of lateral spines fewer and stouter than in fig. 1, but meeting and interdigitating in and near the middle line. Fusions here occur, giving rise to elongate, oval pores between the fused branches, often subdivided by the ultimate branches of the spines, the individual limits of which remain distinct. The secondary orifice formed in this way has no distinct proximal boundary, as the ultimate branches of the spines project irregularly and in a variable way into it. The branches of the oral spines unite with one another (as in fig. 1), and occasionally with the frontal shield of the next distal zooecium. The avicularia have no outer spine.

(d) Loyalty Is, Miss Philipps, Cambridge Coll. — Zooecia with broad, short connecting processes and large fenestrae. Avicularia unilateral. A complete, raised frontal shield is formed, the limits of the zooecia having become indistinct, and it is constituted by the horizontal components of the principal spine of the avicularium. The first and second bifurcations are thick, and the pores between them are large, uninterrupted and oval. Their later bifurcations unite with any part, of their own zooecium or of neighbouring zooecia, which is suitably situated; — with their own opposite spine, with the avicularian spine of an adjacent zooecium, with the back of an avicularium, or with the branches of the distal spines of another zooecium. The limits of

the spines remain distinguishable. The other lateral spine has its branches mainly vertical and takes an inappreciable part in the formation of the frontal shield. Two of its branches usually stand up vertically from the lateral wall. The distal spines bifurcate only once or twice and are subvertical, their inner branches uniting as in fig. 1. The avicularium bears a moderate number of short, conical tubercles, low down on its outer wall. The proximal margin of the secondary orifice is fairly well marked, usually with a short, bifid branchlet projecting into it on the side opposite the avicularium.

(e) Off Adelaide, Dr. J. C. Verco, Cambridge Coll. (fig. 3). — Zooecia very *Beania*-like, with connecting processes and large fenestrae. Avicularia unilateral, the rostrum very prominent, compressed but not carinate, projecting vertically and inwards so as to overhang the secondary orifice; as distinguished from (d), in which the rostrum is over the lateral wall. Frontal shield in the main as in (d), but with smaller pores between its first bifurcations. The lateral spine opposite the avicularium forms, however, a part of the shield, having a small, considerably branched portion in a position corresponding with that of fig. 1. Several of the ultimate branches of the spines project as denticulate processes into the secondary orifice. Distal spines more massive than in (d); their ultimate branches not standing up above the frontal shield. Usually two conical spine-branches on the outer side of the avicularium, including a strong hook, vertical and curving inwards opposite the base of the mandible. The union of the branches which constitute the frontal shield is very intimate, but the limits of the spines can generally be detected. Some of the fine, ultimate branches of the spines project into the space between the frontal shield and the frontal membrane.

Fig. 2. — *Hiantopora intermedia* (Cambridge, Mus. Zool., Japan, 28.G). Part of zooecium, with two avicularia. Obj. C, reduced $^4/_5$.

(f) Off Tokyo, Japan, A. Owston, Cambridge Coll. (text-fig. 2). — Zooecia larger than usual, the fenestrae between the connecting processes small but distinct. Avicularia paired, very prominent, projecting inwards as in (e), the rostrum compressed and carinate on its back. Frontal shield formed equally by the two lateral spines, the earlier bifurcations of which are unusually massive, the pores correspondingly small, and nearly always subdivided by the fine, ultimate branches of the constituent spines, some of the branches standing up above the level of the shield. The union of the lateral spines is specially intimate, and their limits are only partially recognisable. Secondary orifice Lepralioid, the spine-branches on its proximal side ending abrubtly in a distinct transverse line. Distal spines rather massive, free or with their inner branches uniting as in fig. 1, once or twice bifurcate, the ultimate branches standing up vertically above the frontal shield. Avicularia with a number of short, conical projections on their outer sides. The basal wall of the zooecia has only a few rootlets, and some zooecia have none.

The facts recorded above seem to indicate that connecting processes separated by fenestrae are a typical feature of the genus, although they are frequently represented by mere vestiges or are absent. The variations in the mode of formation of the frontal shield are of great interest, and it follows from the descriptions given that when one avicularium is present its principal spine forms the greater part of the shield, and that when there are two both take an equal part. Owing to differences in the branching of the spines, and in their size, there is much variation in the form and size of the pores of the shield, and in the number of spinelets which appear on the outer sides of the avicularia. The main characters of the zooecia are, however, substantially alike throughout, and I am satisfied that all the specimens (a) to (f) belong to one species.

Ovicells are absent in all the specimens, but they have been described by ORTMANN in *Tremopora dendracantha*, which appears to be a synonym of the present species. They are distinctly smaller than those of *H. radicifera*.

15. **Nellia** Busk.

Farcimia (pars) auctt.
Nellia Busk, 1852, BMC, p. 18.
Nellia Levinsen, 1909, MSSB, p. 119.
Nellia Canu and Bassler, 1920, USNMB, 106, p. 195.
Genotype, *Nellia oculata* Busk, 1852 (see HARMER, 1923, JLS, XXXV, p. 314).

Zoarium consisting of erect, quadriserial branches, jointed at the bifurcations. Zooecia in alternate pairs, those of each pair opening on two opposite faces of the internode, which consists of a 4-sided prism, the basal surfaces meeting in a spindle-shaped area, about half the length of the zooecium. Frontal membrane more or less oval, occupying most of the front; the opesia smaller, owing to the development of a slight cryptocyst, which is most extensive proximally. Spines wanting. Gymnocyst short, except at the base of an internode, bearing a pair of avicularia, vestigial or with pointed mandibles, situated proximally to the opesia, or at its sides. Ovicells small, entozooecial. Septula uniporous, one terminal and a pair lateral.

I have already given my reasons (1923, JLS, XXXV, pp. 308, 314) for rejecting *Farcimia* as the name of this genus. I do not follow LEVINSEN (p. 88), and CANU and BASSLER, in placing *Nellia* in the Farciminariidae.

It seems probable that *Nellia* is related to the Cretaceous genera *Flustrina* (*pars*) D'Orbigny (1852, PFTC, pp. 240, 298) and *Filiflustrina* D'Orbigny (1853, PFTC, p. 575). *Flustrina* D'Orb. was antedated by *Flustrina* Van Beneden (1849, Bull. Acad. Roy. Belg., XVI, p. 651), itself a synonym of *Carbasea* Gray (1848, BMRA, pp. 105, 146).

1. *Nellia oculata* Busk.

(?) *Cellaria tenella* Lamarck, 1816, ASV, p. 135; "les mers Australes".
Salicornaria dichotoma Busk, 1852, VR, p. 367. Torres Straits, 9 fath.
Nellia oculata Busk, 1852, BMC, p. 18, Pl. LXIV, fig. 6; Pl. LXV (bis), fig. 4. Same locality; — 1884, Chall., p. 27. New Guinea, Philippine Is., Heard Id., Crozet Is., off Brazil.
Nellia oculata Smitt, 1873, KVAH, XI, 4, p. 3. Pl. I, figs 53, 54. Florida, 13—138 fath.
Nellia oculata MacGillivray, 1880, PZV, V, p. 51, Pl. XLIX, fig. 5—5*b*. Victoria.
Nellia oculata Haswell, 1880, PLSNSW, V, p. 36 (no descr.). Queensland.

Nellia oculata Hincks, 1887, JLS, XXI, p. 121. Mergui Archipelago, Burma.
Nellia oculata Thornely, 1905, PGM, p. 110 (no descr.). Ceylon; — 1907, MPIM, p. 185 (no descr.). Gaspar Straits, Indian Ocean, Andaman Is.
Nellia oculata Osburn, 1914, CIW, 182, p. 191. Tortugas Is. (Florida).
Nellia oculata Canu and Bassler, 1920, USNMB, 106, p. 196, Pl. LXXXII, figs 6—10; — 1923, USNMB, 125, p. 55, Pl. II, figs 5—7. Tertiary, U. S. America and other localities.
Nellia oculata Marcus, 1921, KVAH, LXI, 5, p. 5. N.W. Australia; — 1921, IPBS, p. 3. Between Singapore and Batavia; — 1922, AI, p. 423. Aru Is.
Farcimia oculata Waters, 1887, AMNH, 5, XX, p. 92. N. E. Australia; — 1909, SRS, p. 167. Sudanese Red Sea, Brit. E. Africa, Zanzibar; — 1913, BEA, p. 489, Pl. LXVII, figs 8, 9.
Farcimia oculata Robertson, 1921, BBB, p. 45 (no descr.). Laccadive Is. and other Eastern localities.
Nellia tenella Levinsen, 1909, MSSB, p. 120, Pl. I, figs 13*a*—*e*.

1a. *Nellia oculata* Busk, var. *quadrilatera* D'Orb.

Cellaria quadrilatera D'Orbigny, 1851, PFTC, p. 29; "mers de la Chine".
Farcimia quadrilatera Waters, 1905, AMNH, 7, XV, p. 3.

Typical form and specimens transitional to var. *quadrilatera*.

435. A. Stat. 7. Batjulmati, Java, 15 M. and more.
380. J. Stat. 47. Bima, Sumbawa, N., 55 M.
16. A. Stat. 49a. Sumbawa, E., 69 M.
319. E. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
30. A. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M.
272. A. Stat. 60. 303. Haingsisi, Samau Id., W. Timor, 0—36 M.
333. B. Stat. 64. Tanah Djampeah, between Flores and Celebes, 0—32 M.
378. B. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
38. A. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
618. A. Stat. 78. Borneo Bank, Strait of Makassar, 0—34 M.
653. B. Stat. 79. Borneo Bank, Strait of Makassar, 41—54 M.
57. I. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
467. C. Stat. 91. Moearas Reef, E. Borneo, 0—54 M.
595. C. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.
480. A. Stat. 114. Kwandang Bay, N. Celebes, 75 M.
396. A. Stat. 162. Off Loslos Id., N. end of New Guinea, 18 M.
612. D. Stat. 163. Seget, N. end of New Guinea, 29 M.
135. A. Stat. 164. W. of N. end of New Guinea, 32 M.
343. B. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
357. B. Stat. 240. Banda, Banda Sea, 0—45 M.
313. B. Stat. 273. Jedan, Aru Is., 13 M.
199. B. Stat. 274. Off Jedan, Aru Is., 57 M.
208. A. Stat. 282. Timor, E., 0—54 M.
209. A. Stat. 285. Timor, E., S. coast, 34 M.
411. A. Stat. 310. Sumbawa, E., 73 M.
256. A. Stat. 313. Saleh Bay, N. Sumbawa, reef.
374. B. Locality not recorded.

var. *quadrilatera*.

40. B. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
135. B. Stat. 164. W. of N. end of New Guinea, 32 M.
555. E. Stat. 320. Java Sea, 82 M.
416. B. Stat. 321. Java Sea, 82 M.

1. *Nellia oculata*, typical form. (Pl. XIV, fig. 18; text-figs 3 *B.*, *D.*; 4 *A.*, *B.*).

Colonies luxuriantly branched, reaching a length of about 25 mm.; commencing with a stalk formed of altered zooecia, attached by a dense tuft of rootlets. Internodes short near the proximal end of the colony, increasing in length distally. Aperture occupying most of the front, its edges considerably raised, reduced by a slight cryptocyst proximally; a gymnocyst on the proximal side of the opesia, constantly bearing a pair of vestigial or functional avicularia which are broadly triangular in side view.

1a. var. *quadrilatera* D'Orb. (Pl. XIV, figs 19, 20; text-fig. 3 *A.*, *C.*; 4 *C.*).

Colonies less branched, reaching a length of 100 mm. Internodes much longer than in the typical form, more definitely square in transverse section (text-fig 4 *C.*), the zooecia longer, but with less raised margins. Avicularia functional, with a short, acutely pointed rostrum, projecting further beyond the general surface than in the typical form, relatively narrow in side view.

The present species was originally described by Busk as *Salicornaria dichotoma*, a name which was pre-occupied by Schweigger 1819 (Harmer, 1923, JLS, XXXV, p. 314), and this was presumably Busk's reason for altering the trivial name to *oculata*. I follow Waters (1913, BEA, p. 490) in not accepting *Cellaria tenella* Lamarck (although I expressed a different view in 1923), as the description given by that author is insufficient to distinguish it from other jointed species. The form which I describe as var. *quadrilatera* appears to be the *Cellaria quadrilatera* of D'Orbigny, who comments on the long, delicate segments of this form. It should be noted that Waters (1905) has definitely referred it to *N. oculata*, from his examination of D'Orbigny's material.

The distribution of this common species is remarkable, since it seems to occur in two widely separated regions: — (1) from Victoria along both E. and W. coasts of Australia to the Malay Region; various parts of the Indian Ocean, as far S. as Heard Id, and extending to the E. coast of Africa and the Sudanese Red Sea. It does not seem to have been recorded from S. Africa, New Zealand or Japan; (2) Florida and Brazil. It has also been recorded by Canu and Bassler from Tertiary formations in France and the United States; and the Tertiary *Farcimia bituberculata* Canu (1907, AP, II, p. 73; sep., p. 17) has much resemblance to the more proximal internodes, altered by the occlusion of parts of the opesiae, of *N. oculata*.

The internodes of the typical form (fig. 18) do not usually consist of more than about 11 zooecia on each face. The margins of the zooecia are well raised, the ovicells being raised to the same extent. The fertile zooecia are not obviously wider at their proximal end. The terminal walls of the zooecia (text-fig. 3 *B.*, *t. w. l.*) commence not much in advance of the proximal end of the opesia of their lateral neighbours. The avicularia are commonly vestigial, without mandibles, forming slight frontal prominences pierced by two pores; and in side view (*av. l.*) they appear broadly triangular, widening greatly to their frontal surface. The measurements of the zooecia are relatively small.

In var. *quadrilatera* (figs 19, 20) the margins of the zooecia, which are larger than in the typical form, are hardly raised, and the ovicell is also less raised. The fertile zooecia are widened at their proximal end (fig. 20), and their greater width proximally throws the distal

ends of the adjacent zooecia outwards, the edge of the branch thus appearing serrate. In infertile branches (fig. 19) the sides are remarkably straight, the avicularia projecting beyond them. The internodes may have more than 30 zooecia on each face. The terminal walls (text-fig. 3 *A.*, *t. w. l.*) commence well in advance of the proximal ends of the opesiae of their neighbours. The avicularia are functional and project considerably, being traversed by a calcareous bar, indicating the proximal end of the acutely pointed rostrum, which is directed proximally in ordinary zooecia (fig. 19), outwards on the distal side of an ovicell (fig. 20). In side view (text-fig. 3 *A.*, *av. l.*), they are relatively narrow, not much longer at their frontal ends. The spines borne by the inner border of the avicularium (text-fig. 3 *C.*) are larger than in the typical form (text-fig. 3 *D.*). In spite of these differences, certain colonies (*e. g.* Stations 49ª, 53, 285) appear to be intermediate between the two forms, and I cannot definitely refer them to one rather than to the other. It thus seems necessary to consider the second form as a variety of the first.

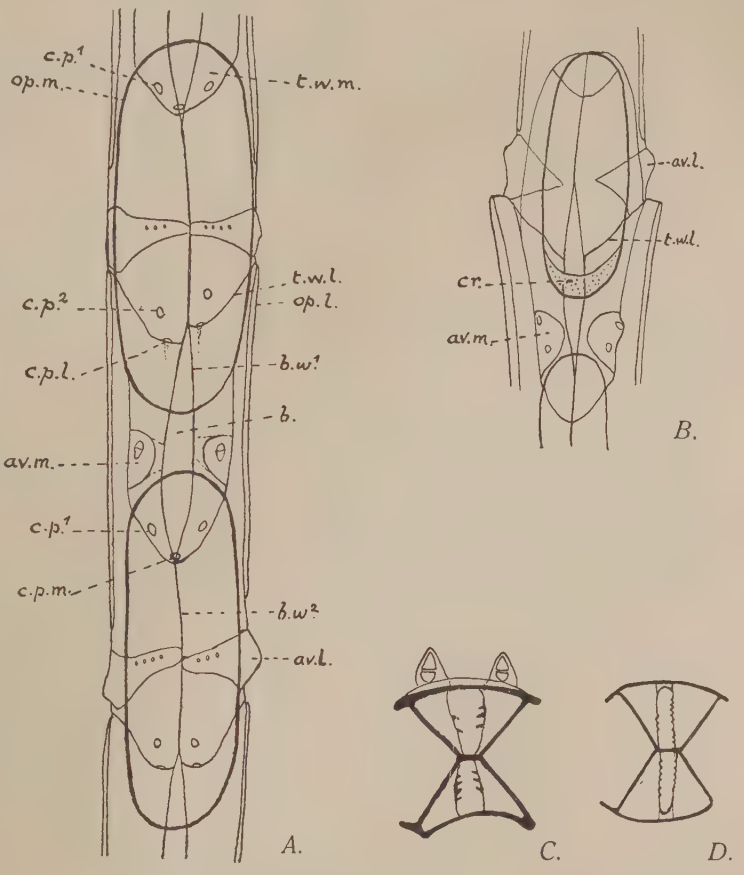

Fig. 3. — *Nellia oculata.* Illustrating the relations of the parts of the internode to one another. In *A.* and *B.* the zooecia which are seen in frontal view are designated as "median", those seen in side view as "lateral". Obj. *C.*, reduced $^2/_3$.

A., var. *quadrilatera* (40. B.²); *av. l.*, avicularium of lateral zooecium; *av. m.*, of median zooecium; *b.*, proximal part of the basal wall of median zooecium, in contact with that of the other member of its pair, on the opposite face of the internode; *b. w.*¹, distal part of the basal wall of lateral zooecium, separated from that of its fellow by the portion *b.*; *b. w.*², proximal part of the same wall, in contact with that of the other member of its pair; *c.p.*¹, lateral (proximal) communication-pore of median zooecium; *c.p.*², the corresponding pore of lateral zooecium; *c.p. l.*, terminal communication-pore between two lateral zooecia; *c.p.m.*, a similar pore between two median zooecia; *op. l.*, edge of opesia of lateral zooecium; *op.m.*, the same part of median zooecium; *t. w. l.*, terminal wall of lateral zooecium; *t. w. m.*, the same part of median zooecium.

B., typical form (16. A.); *cr.*, cryptocyst; other lettering as in *A.*

C., var. *quadrilatera* (416. B.¹); transverse section showing two pairs of avicularia, cut at different levels on the two sides, and the narrow part of the body-cavity of the zooecium between each two. The inner borders of the avicularia bear spines, projecting into the body-cavity.

D., typical form (396. A.²); a similar section.

The joints of this species resemble those of the Scrupocellariidae in being composed of parallel chitinous tubes, but it does not seem to have been previously noticed that these are three in number. This is clearly seen by the examination of either the distal end (text-fig. 4 *B.*) or the proximal end of an internode.

The bifurcation is illustrated by text-fig. 4 *A.*, where it is seen that one (B) of the two distal zooecia visible is in advance of the other (A). B gives rise to two distal successors, each of which contributes a chitinous tube to the joint. D is a fully formed zooecium, which has a pair of vestigial avicularia on the distal side of the joint. F is shorter and has no avicularia. A gives rise to C, which

has a long gymnocyst (C^1), bearing a pair of avicularia, situated in the parent internode. C contributes a single chitinous tube; and its opesia, on the distal side of the joint, is short. E originates with a pointed end at the distal side of the joint, and it is a complete zooecium, with avicularia. On reversing the slide, exactly the same arrangement is seen, except that B of the face then in view lies opposite the A zooecium first indicated, while A is opposite the first B.

Each median pair of zooecia alternates with a similar pair on the lateral sides of the branch (text-fig. 3 *A.*, var. *quadrilatera*). Each zooecium overlaps its predecessor on the basal side, in a subconical portion (*t.w.m.*) visible at the distal end of the opesia of its predecessor. On each side of this overlapping part is a communication-pore (*c.p.*^{1}, *c.p.*^{2}), leading to the next alternate zooecium and opening into it at its middle; while a single communication-pore (*c.p.m.*, *c.p.l.*) connects two zooecia of the same row. The basal wall (*b.*) is represented by a spindle-shaped region occupying the proximal half of the zooecium; this spindle being the wall which is common to it and the opposite member of its pair. As seen in frontal view, each zooecium is traversed by a median sutural line in its distal half, representing a spindle seen edgeways, the basal walls of the laterally placed zooecia being here in contact. The communication between the proximal end of the zooecium and the major part of the body-cavity is reduced to a narrow channel (text-figs 3 *C.*, *D.*) by the presence of the avicularia, the inner faces of which bear a vertical series of spines, projecting into this channel, better developed in var. *quadrilatera* (text-fig. 3 *C.*) than in the typical form (*D.*). These spines are seen in the lateral avicularia through their walls rendered transparent by mounting in Canada balsam (text-fig. 3 *A.*). The function of these spines is perhaps to serve as guides for the muscles retracting the polypide, the end of which is drawn through the narrow channel to the proximal termination of the zooecium.

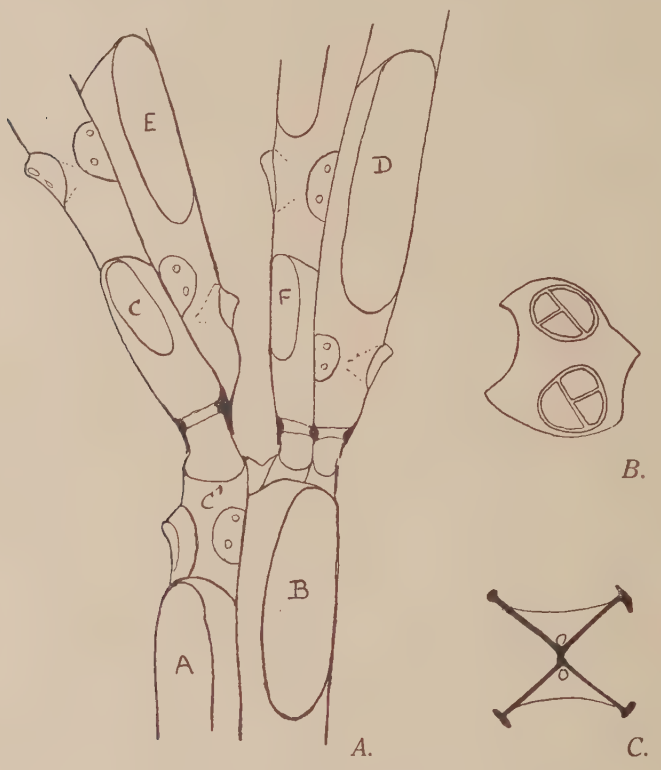

Fig. 4. — *Nellia oculata.*

A., typical form (16. A.); illustrating the bifurcation and jointing. For explanation see text. Obj. *C.*, reduced $^2/_3$.

B., typical form (396. A^2); distal end of an internode, to show the two groups, each of three calcareous tubes, which contain the proximal ends of the corresponding chitinous tubes of the joint.

C., var. *quadrilatera* (416. B.^{1}); transverse section illustrating the regular prismatic formation of the internode. Two of the zooecia are cut near their proximal ends and thus show the terminal communication-pores.

Fig. 20 shows the broadened proximal ends of the fertile zooecia, in var. *quadrilatera*. The ovicell is vestigial, but a low wall on the proximal side of its arch represents the terminal wall of the zooecium with which it is connected. In the typical form (fig. 18), the fertile zooecium is not widened proximally, the ovicell is not quite so vestigial, and a transverse fenestra represents

the separation between its ectooecium and entooecium. A suture on each side marks off the ovicell from the adjacent lateral edge of the zooecium.

The proximal tuft of rootlets is extremely dense; and, as WATERS has shown (1913, BEA, p. 489, P. LXVII, figs 8, 9), young colonies are given off by the rootlets. Information with regard to the ovicells and ova is given in the same paper. LEVINSEN (1909, MSSB, pp. 119, 120) has also described certain details of structure.

2. *Nellia tenuis* n. sp. (Pl. XIV, figs 16, 17; text-fig. 5).

439. C. Stat. 37. Sailus Ketjil, Paternoster Is., 0—27 M.
361. B. Stat. 89. Kaniungan Ketjil, E. Borneo, 0—11 M.
Type. 487. B. Stat. 129. Karkaralong group, S. of Mindanao, 0—31 M.

British Museum: —

Tizard Bank, China Sea, 6 fath., 89. 8. 21. 40 (fragment, as *Farcimia cereus* Pourt.).

Habit typical, a series of upright stems being given off from creeping rootlets. Internodes short, narrow at the base, which is composed of two zooecia. Aperture occupying most of the front, except in the proximal zooecia of the internode, the cryptocyst well developed proximally and narrower laterally. Avicularia opposite the proximal cryptocyst, diverging outwards and closely connected with the margins of the preceding alternate zooecia of the adjacent series; mandibles acute and hooked. Ovicells more developed than in *N. oculata*.

This species is represented by small fragments from three Stations. The erect stem rises from a system of branching chitinous rootlets, of which a portion of variable length becomes calcified at the origin of the stem. The calcified part radiates out other chitinous rootlets, and on its upper face gives rise to a short cylindrical tube, followed by a chitinous joint. Two or three narrow, elongated kenozooecia, separated by joints, follow in a single series; and are succeeded by an internode of the ordinary type. Rootlets may be produced in considerable numbers at the base of an internode.

The general structure is essentially as in *N. oculata*, with certain differences. The two zooecia of a pair meet one another basally in a wide spindle (fig. 17), most of which is visible through the opesia, its proximal part lying under the proximal cryptocyst. The communication-pores appear to be as in the preceding species, and those corresponding with $c.p.^2$ in text-fig. 3 *A*. (*N. oculata*, var. *quadrilatera*) are easily found. The similar pores of the "median" zooecia ($c.p.^1$ in fig. 3 *A*.) were not seen with certainty, and the terminal pore is also concealed. The avicularia lie in the frontal plane, instead of passing towards the basal surface as in *N. oculata*; and in consequence of their connexion with the distal ends of the adjacent zooecia it might be uncertain to which row they should be referred. Comparison with the other species leaves little doubt on this point, and those which are directed outwards when any series of zooecia is seen in frontal view belong to this row.

The bifurcation (text-fig. 5) differs in detail from that of *N. oculata*, the internode being composed of two zooecia instead of three at its proximal end. Denoting the zooecia of the four rows by the symbols *I—IV*, the arrangement is as follows. Each row of the parent-internode gives rise to one of the chitinous tubes forming the two joints. Each distal zooecium (*Ia*, *IIIa*)

of the two lateral rows produces a zooecium (*Ib*, *IIIb*) traversed by a joint near its proximal end, the two belonging to different branches; the short proximal segment bearing an avicularium at the distal end of the parent-internode, and the long distal segment having an opesia but no avicularium. The two branches are not in corresponding positions, the right one having been turned round so that its two proximal zooecia are seen in side view. *Ib* thus shows at its distal end two avicularia, one of which belongs to each of the adjacent zooecia, while *IIIb* shows only one avicularium at its end. The other two rows of the parent-internode lie medianly; and the zooecia to which they give rise have no avicularia, though each has a short, proximal segment in the parent-internode. *IIa* and the proximal segment of *IIb* lie on the upper side of the branch as mounted. *IVa* is of course on the opposite side, and is not visible; and the proximal segment of *IVb* lies on the same side, but comes into view in the figure. The major part of *IVb* is concealed by *Ib*. Near the distal end of the proximal pair of zooecia of each branch, another row is intercalated on each side, and the 4-serial condition is thus attained.

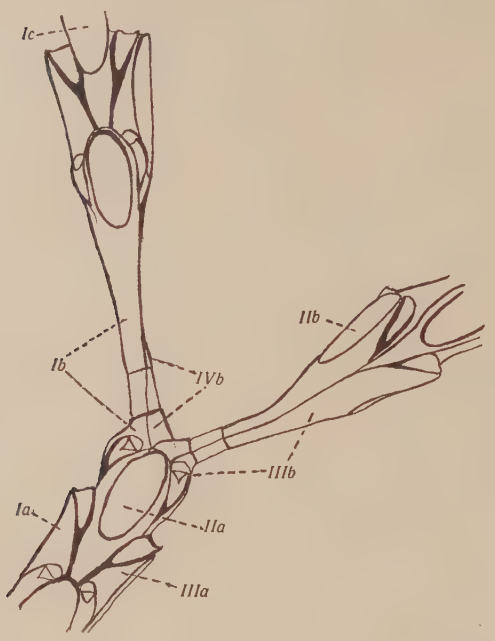

Fig. 5. — *Nellia tenuis*. — Bifurcation (487. B.[1]). The four rows of zooecia are designated *I*—*IV*. The zooecia marked *a* belong to the parent internode. See description in text. Obj. A, reduced $^2/_3$.

The ovicell is seen in Pl. XIV, fig. 17, and though small is moderately well developed. The transverse line at the base of the operculum is the frontal edge of the terminal wall of the fertile zooecium.

The present species is undoubtedly closely related to the Victorian *Nellia appendiculata* Hincks[1]) from which I think it is distinguishable. In Hincks' species the internodes and the zooecia are relatively broad, the proximal end of the internode is not narrow and cylindrical (*cf.* MacGillivray's fig. 6*a*), and many of the avicularia, which are broad and not much curved, are prolonged into long, tubular, acuminate processes. These have been figured by Hincks, MacGillivray and Levinsen; and are present in all the specimens, from Victoria, in the British Museum. Levinsen has described the cummunication-pores of *N. appendiculata* (see his figs 11 *a*, *b*); and they agree in their position with those of the other species of *Nellia* here considered.

Waters (1909, SRS, p. 167) thinks that *N. appendiculata* is a synonym of *Membranipora articulata*, described by him in 1882 (QJGS, XXXVIII, p. 264, Pl. VIII, fig. 15, 16); and this view has been supported by MacGillivray (1895, TRSV, IV, p. 50). The opesia seems to be very different in the two species, and I am not convinced that Waters' view is correct.

16. **Foveolaria** Busk.

Foveolāria Busk, 1884, Chall., p. 68.
Foveolaria Canu, 1900, BSGF, 3, XXVIII, p. 381.

1) *Farcimia appendiculata* Hincks, 1883, AMNH, 5, XI, p. 199, Pl. VII, figs 4—4*b*; — 1893, AMNH, 6, XI, p. 177; — MacGillivray, 1889, PZV, XVIII, p. 289, Pl. CLXXVIII, figs 6—6*b*; *Nellia appendiculata* Levinsen, 1909, MSSB, p. 119, Pl. I, figs 11 *a*, *b*.

Foveolaria Levinsen, 1909, MSSB, p. 152.
Foveolaria Canu and Bassler, 1920, USNMB, 106, pp. 84, 174, 177, 178.
Genotype, selected by CANU, 1900, *F. elliptica* Busk, 1884, Chall., p. 68.

Erect, bifurcating; branches free or retiform, Vincularian, unilaminar, or foliaceous and bilaminar. Frontal membrane depressed. Cryptocyst thick, descending steeply into the body-cavity. Avicularium unilateral, with pointed rostrum and mandible, near the proximal or lateral side of the opesia. Ovicells hyperstomial.

This genus was established by BUSK, for four species, of which CANU selected *F. elliptica* as the genotype, while LEVINSEN considered it the only one referable to the genus. I am inclined to think that the four species, with the possible exception of *F. orbicularis*, were correctly placed together by BUSK.

Foveolaria appears to be allied to *Adenifera*, established by CANU and BASSLER (1917, USNMB, 96, p. 12; see also 1920, USNMB, 106, pp. 84, 102), with the genotype *Biflustra armata* Haswell (1880, PLSNSW, V, p. 38). This species was doubtfully recognised, in a collection from British E. Africa, by WATERS (1913, BEA, p. 486, Pl. LXVII, fig. 10; Pl. LXXI, figs 5—10), who described a distal avicularium, as shown by HASWELL, and a "gland" (perhaps a vestigial avicularium) on the opposite side of the zooecium, in a position corresponding with that of the avicularium. This is obviously the structure alluded to by CANU and BASSLER, in their inadequate generic diagnosis "With a distal glandular penthouse". WATERS further stated that, in a considerable number of the zooecia, two complete polypides occur.

A specimen, in the Cambridge collection (BM), from unsorted Queensland material forming part of HASWELL's original collection, appears to belong to the species described by HASWELL and WATERS. It is bilaminar, with large zooecia and cryptocyst, in these respects resembling *F. retiformis* described below. A large unilateral avicularium occurs near the distal end of the zooecium, as in HASWELL's account, its rostrum acute and directed proximally. The communication-pores are septula, and are present in large numbers, scattered over the whole extent of the lateral and terminal walls, which are very high. This arrangement differs so much from that of *Foveolaria*, in which there are multiporous rosette-plates (LEVINSEN, 1909), that the two genera should probably be considered distinct.

1. *Foveolaria retiformis* n. sp. (Pl. XIV, figs 21—23; text-fig. 6).

Type. 79. A. Stat. 105. Sulu Archipelago, 275 M. One fragment, retiform.
82. C. Same Station. One young colony, encrusting 82. A, *Hornera spinigera* Kirkp. (this Rep., Pt I, p. 147).

Erect, unilaminar, with flattened branches, retiform, the meshes longer than wide, wider than the branches. Zooecia deep, biserial or triserial, increasing to quadriserial before a bifurcation; outlined by a distinct, hexagonal, sutural line, within which the wall is thick and vitreous. Oral spines short, typically three; — two external and distal, in marginal zooecia at least, and one internal, situated rather more proximally; the full number, and particularly the inner spine, not always discoverable. Cryptocyst extensively developed all round, covered with numerous small tubercles and, like all other calcareous parts, massive; sloping steeply in a basal direction to the edge of the opesia, which is more or less oval. Operculum large and strong, at the

distal end of the opesia, Membraniporine, without basal sclerite. Avicularium unilateral, at the proximal end of the opesia, directed in an obliquely transverse direction towards the opposite side, the tip of the rostrum overhanging the proximal cryptocyst. Rostrum and mandible triangular at the base, acute and nearly acicular distally. Ovicells large, smooth and vitreous, imperforate, the ectooecium not reaching the oral arch, and separated from it by a flat, crescentic part of the entooecium. Basal surface flattened, but with an irregular surface, imperforate except for a few very fine pores in a thin region near the middle of the zooecium; the outlines of the zooecia not conspicuous. A few strong, slightly calcified and irregularly jointed rootlets given off by some of the marginal zooecia, at the distal end.

Fig. 6. *Foveolaria retiformis.* Part of zoarium (79.A), natural size.

79. A, a fragment without its attached part, is hardly distinguishable, without magnification, from a Retepore. 82. C, from the same Station, is a minute colony of about 14 zooecia, and I regard it as the initial stage of *F. retiformis*. The zooecia are shallow, not having the great depth of the mature zooecia, and show slight indications of distal spines, the margins being otherwise unarmed. The cryptocyst is narrow and tuberculate, with a tendency to grow down in a basal direction; and, owing to its slight development, the opesia is relatively large. The zooecium which appears to be the ancestrula is smaller than the rest, and has an oval opesia, which in the others is wider proximally than distally. A few avicularia are present, with an acute rostrum, raised at the tip.

In habit the retiform stage of this species closely resembles *Cellepora sigillata* Pourtales [1]), which was re-described and figured by Smitt [2]), as *Membranipora sigillata*, from 262—270 fath., off Havana and Florida. The two species agree in having a central, thinner area in the middle of the basal surface of the zooecium, but *M. sigillata* differs in various respects from *F. retiformis*, as in the position of the avicularia, which occur on the sides and basal surface of the branches, as well as on the proximal side of the opesia.

Fam. 3. Flustridae.

Levinsen (1909, MSSB, p. 122) characterised this Family principally by the possession of entozooecial ovicells and of vicarious avicularia, as well as by the slight calcification of the zooecia and by the large aperture. The communication-pores are, with few exceptions, uniporous, and the cryptocyst is wanting or slight. The zooarium is typically erect and frondose, but a few encrusting species are perhaps to be referred to the Family.

Although the Flustridae are nearly related to those Membraniporidae which have at most a slight cryptocyst, they should probably be considered distinct. The characteristic free growth, with flattened and usually much expanded fronds, may be regarded as the common heritage of nearly all the species. The occurrence of vicarious avicularia points to a derivation from primitive forms of Membraniporidae.

1) Pourtales, 1867, BMCZH, I, p. 110. "Operculum" in this description is no doubt a *lapsus calami* for ovicell.
2) Smitt, 1873, KVAH, XI, N° 4, p. 8, Pl. II, figs 64—68.

1. Carbasea Gray.

Carbasea Gray, 1848, BMRA, pp. 105, 146.
Carbasea (pars) Busk, 1852, BMC, p. 50; — 1884, Chall., p. 55.
Flustrina Van Beneden, 1849, Bull. Ac. Roy. Belge, XVI, p. 651; with the same genotype (nec *Flustrina* D'Orbigny, 1852, PFTC, pp. 240, 298).
Genotype, *Flustra carbasea* Ellis and Solander, 1786, NHZ, p. 14 (see Harmer, 1923, JLS, XXXV, p. 301).

Carbasea was distinguished by Gray as being unilaminar. Many authors, who regard the zooecial characters as all-important and the zoarial form as of no significance as a guide to affinity, have refused to accept this distinction. I think that in this Family at least the zoarial form has a high taxonomic value, and that there is no sufficient reason for disregarding it, even though a similar habit may be assumed by members of other Families.

It does not follow that all unilaminar Flustrine species belong to the same genus. *C. carbasea*, the genotype, has no avicularia or ovicells; and their absence may be a primitive character. It will possibly be necessary to separate those species which have acute avicularia from those in which avicularia are absent, or, if present, have rounded mandibles.

Kenella Levinsen (1909, MSSB, p. 124) was based on *Flustra biseriata* Busk (1884, Chall., p. 54), the genotype, a bilaminar species without avicularia. It was characterised by the fact that the ovicell is immersed in a kenozooecium, doubtless on the evidence given by Waters (1896, JRMS, p. 290, Pl. VIII, fig. 7).

1. *Carbasea linguiformis* n. sp. (Pl. XV, fig. 5; text-fig. 7).

498. A. Stat. 159. W. of Salawatti, N. end of New Guinea, 411 M. One specimen.

Unbranched and tongue-like, unilaminar, with narrow marginal kenozooecia, attached by a tuft of fine rootlets given off at the end of a narrow stalk, supported by a calcareous axis. Zooecia shallow, extremely large and wide, usually widest at the middle, the distal margin forming a thin slightly everted film. Calcification slight, basal and frontal walls practically uncalcified. Aperture occupying the entire front, a narrow cryptocyst distinguishable, especially at the outer sides of the proximal margins of the opesiae of marginal zooecia. Orifice nearly terminal, the operculum without a basal sclerite. Avicularia wanting. Ovicells large, longer than wide, with a median frontal suture.

Fig. 7. — *Carbasea linguiformis*. Zoarium (498. A), natural size.

The single colony is 31 mm. long, its greatest width 5 mm., the zooecia (some of which have dropped out) with a maximum width of about 1 mm. The narrow stalk is supported by a calcareous axis, which consists of longitudinal, calcareous fibres. It is invested by a membrane, crossed at intervals by incompletely circular sclerites. At its distal end the calcareous axis diverges at a small angle into two bands of fibres, which run along the edges of the flattened frond, close to the outer walls of the marginal zooecia; a single, median zooecium occurring between the diverging limbs. The lateral and terminal walls of the zooecia are calcified, as is the outer part of the basal wall, which is otherwise membranous. The communication-pores are not well seen, but a longitudinal row seems to occur on each lateral wall, and a transverse row on the terminal wall. The

polypide, which occupies but a small part of the body-cavity, has about 26 tentacles, and the lophophore has a conspicuously large circular canal (Fig. 5). The wide pharynx passes by a short oesophagus into a dilated stomach, the caecum of which is directed distally during retraction, and is connected by a funicular strand with the body-wall. The occlusor-muscles originate from the basal wall, and a pair of muscles pass to the vestibule from near their inner and proximal sides. Two bands connect the tentacle-sheath with the frontal wall, and a similar pair with the basal wall. One pair of parietal muscles are usually inserted near the proximal corners of the operculum, and a second pair near the middle of the zooecium. Two additional parietal muscles were observed, more proximally, on one side, in a single instance. The ovary is small and lies on the basal wall, asymmetrically, at about the middle of the length of the zooecium. The retractor-muscles originate near the middle or at one end of the terminal wall.

The large ovicell has a median suture, formed by the incomplete union of the two halves of the calcified, imperforate entooecium. Its proximal lip is at some distance from the preceding operculum, and is reflected distally, extending also outwards, beyond the lateral margin of the ovicell. This reflected portion may be regarded as a partially calcified ectooecium, the remainder of which is membranous.

The present species resembles *C. pedunculata* Busk (1884, Chall., p. 56), obtained by the Challenger off the Azores, 450—900 fath. Like that species, it is very delicate in texture and has conspicuously large zooecia, but it differs from it in the following respects. In *C. pedunculata* the ovicell is represented by a slightly produced lip of the distal wall of the fertile zooecium, in which I have found a large egg, contained in an ovisac lying in the body-cavity. The zooecia are narrower than in the present species, the marginal kenozooecia are broader, and the calcification is less extensive. The polypides are larger and their retractor-muscles have separate, paired origins, which is not the case in *C. linguiformis*.

2. **Retiflustra** Levinsen.

Retiflustra Levinsen, 1909, MSSB, pp. 124, 126.
Genotype, selected by Harmer, 1923, JLS, XXXV, p. 315, *Retepora cornea* Busk, 1852, VR, p. 380.

Unilaminar, branches narrow and in certain species anastomosing to form a network. Avicularia, if present, nearly as large as the zooecia, the mandible spatulate. Rootlets given off at the angles of the branches.

Levinsen included in his diagnosis the bent or curved junction of the terminal with the basal wall, at least in fertile zooecia, and the position of the free frontal edge of the ovicell, which lies at a lower level (*i. e.*, more proximally) than the basal edge.

1. *Retiflustra cornea* (Busk). (Pl. XV, fig. 3; text-fig. 8).

Retepora cornea Busk, 1852, VR, p. 380. Cumberland Is. (Queensland), 27 fath.
Carbasea cribriformis Busk, 1852, BMC, p. 51, Pl. LXVIII, fig. 1. Same locality; — 1884, Chall., p. 58, Pl. XXXIV, fig. 8. Torres Straits, S. of New Guinea, 8—45 fath.
Carbasea cribriformis Haswell, 1880, PLSNSW, V, p. 37. Queensland.
Flustra cribriformis Waters, 1887, AMNH, 5, XX, p. 93; — 1888, Chall., p. 10, Pl. I, fig. 10; — 1896, JRMS, pp. 281 *et seq.*, Pl. VII, figs 31, 32.

Flustra cribriformis Kirkpatrick, 1890, TS, p. 611. Torres Straits; — 1901, "Guide Shell and Starfish Gall., Brit. Mus." p. 62, text-fig. 11.
Flustra cribriformis Meissner, 1902, ATIB, p. 730. Torres Straits.
Retiflustra cribriformis Levinsen, 1909, MSSB, p. 128, Pl. I, figs 6*a*, *b*; Pl. XXII, fig. 2*a*. Torres Straits, Port Darwin (N. Australia).
Retiflustra cribriformis Marcus, 1922, AI, p. 423. Aru Is.

511. A. Stat. 167. W. of N. end of New Guinea, 95 M.
194. A. Stat. 274. Off Jedan, Aru Is, 57 M.

Cambridge, Mus. Zool.: —

Torres Straits, 11, 79, 106, 165. A. C. HADDON, Reg. Feb. 24, 1898.

British Museum: —

Numerous specimens, including those described by BUSK (1852, 1884) and also from Torres Straits ("Alert" and Haddon collections), Queensland and N. W. Australia (Baudin Id, in Admiralty Gulf, about 14° 8′ S., 125° 36′ E.).

R. cornea occurs, on this evidence, from Queensland to Torres Straits (where it is obviously common) and other parts of N. and N. W. Australia. In the Siboga Collection it is represented only to the W. of New Guinea and off the Aru Is.

Zoarium a low and broad inverted cone, attached by its apex and by rootlets arising from the proximal ends of the fenestrae, the reticulated, unilaminar frond spiral Fenestrae regularly arranged, as in *Retepora*; generally narrower than the branches, which may consist of at least 12 rows of zooecia in the wider parts. Zooecia not uniform in shape, typically more or less hexagonal and relatively short and wide, the distal margin less regularly rounded than in the next species, the cryptocyst less developed and showing only obscure traces of lamination. Basal wall usually with an uncalcified, more or less linear, median region, commencing at the apex of the angular insertion of the distal wall; entirely calcified in some of the old zooecia; commonly showing conspicuous, transverse or slightly oblique striations. Avicularia wanting. Ovicells of moderate size, projecting into the next zooecium; the embryo relatively small and contained in the ovicell. Rootlets stout, the proximal part of their wall thickened and marked by numerous, closely set, annulations; becoming thinner distally and finally giving off a number of delicate lateral branches.

In his original description, BUSK named this species *Retepora cornea*; but later in the same year he correctly placed it in the Flustrine group, and introduced a new trivial name, *cribriformis*. His motive for the change was, presumably, that having removed it from *Retepora* he considered his original name unsuitable. As I find no evidence that *cornea* has been used elsewhere in *Retepora, Carbasea* or *Flustra*, the rejection of this name seems to have been unjustifiable. *Retepora ambigua* Lamarck (1816, ASV, p. 184), which BUSK gave as a doubtful synonym, may be this or the next species, but the description is hardly adequate.

A very beautiful specimen (text-fig. 8) in the British Museum shows the zoarial form more completely than any other I have seen. The colony is a low, inverted cone, of very regular spiral structure, about 16 mm. in height and 42 mm. in greatest diameter. It was obviously attached by its apex, where it may have originated from an encrusting base. The most proximal whorl of the spiral has the full diameter of the cone, and the second whorl is of about the same

size for half its extent, then diminishing in diameter. The spiral is continued to the end of a fourth whorl, which is central and is not much more than one quarter of the diameter of the proximal whorl. The frond is oblique, its free margin external to its basal margin, and reaching the level of the edge of the cup along its whole extent. The other specimens examined are incomplete, but they show the remarkable rootlets described and figured by WATERS (1888). These are produced by the proximal margins of a certain number of the fenestrae, not necessarily at the margin of the frond. Each arises from a triangular, axillary kenozooecium, which it equals in width at its origin, forming a wide, cylindrical tube, at first marked by numerous, closely set, circular annuli. Its uncalcified wall becomes very delicate more distally, finally giving off, all round, a system of fine, lateral branches, by which it is attached. The colony is thus fixed in place by a set of mooring ropes. As in *R. schönaui*, the later whorls are often more slender than those at the proximal end of the spiral, and the delicate distal reticulations consist of fewer rows of zooecia than the proximal ones. When the material is fragmentary it might be supposed that some colonies were more delicate in character than others.

Fig. 8. — *Retiflustra cornea*. — Hardy Id, N.E. Australia, J. B. JUKES, "Alert" Coll. Zoarium, natural size. From R. KIRKPATRICK, 1901, "Guide to the Shell and Starfish Galleries, Dep. of Zool., Brit. Mus. (Nat. Hist.)", p. 63. Reproduced by permission of the Trustees of the British Museum.

Other features of this species are mentioned below, in the comparison with *R. schönaui*.

2. *Retiflustra schönaui* Levinsen. (Pl. XV, fig. 2).

Carbasea cribriformis Kirchenpauer (probably), 1869, Mus. Godeff. Cat. IV, pp. XXI, 118. Formosa [1]).
Flustra cribriformis Harmer, 1902, QJMS, XLVI, p. 265, 301. Singapore.
Flustra cribriformis Robertson, 1921, BBB, p. 46. Singapore.
Retiflustra schönaui Levinsen, 1909, MSSB, pp. 58, 127, Pl. I, figs *7a—d*. China Sea, 42 fath.
Retiflustra schönaui Marcus, 1921, IPBS, p. 3. Gaspar Strait, Singapore.
Retiflustra schönaui Mortensen, 1922, VMNFK, LXXVI, p. 85. Sunda Strait.

432. A. Stat. 2. Madura Strait, 56 M.
433. D. Stat. 7. Batjulmati, Java, 15 M. and more.
39. A. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
57. K. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
259. C. / 415. C. Stat. 318. Off Kangeang Id, N. E. of E. end of Java, 88 M.
263. C. Stat. 319. Java Sea, 82 M.
264. A. Stat. 320. Java Sea, 82 M.
416. C. Stat. 321. Java Sea, 82 M.
374. A. Locality not recorded.

Cambridge, Mus. Zool.: —

Singapore, 15 fath. F. P. BEDFORD, Reg. Nov. 11, 1899.

The Siboga Stations from which *R. schönaui* has been obtained are all off Java or to the

1) In the Zool. Mus., Moscow. See TEPLOW, 1891, Izv. Imp. Obschch. Moskov, LXVII, Trud. Zool. Otd., VI, p. 15.

E. of Borneo. It occurs also at Singapore and in the China Sea (LEVINSEN); and it may be inferred that KIRCHENPAUER's *C. cribriformis*, from Formosa, belongs to this species.

Zoarium with the habit of the preceding species, but with a flatter spiral; the fenestrae usually wider than the branches, which may consist of at least 9 rows of zooecia in the wider parts. Zooecia variable in shape, sometimes short, but usually elongated, with parallel lateral walls, the distal margin uniformly rounded. Cryptocyst more developed than in the preceding species, showing proximally two or three lines of growth, parallel with the edge of the opesia. Basal wall less calcified than in *R. cornea*, the uncalcified region oval, and in young zooecia occupying most of the surface; entirely calcified in the proximal half of old zooecia, the oval, uncalcified area confined to its distal end. Insertion of distal wall into basal wall less strongly angulated than in *R. cornea*. Large vicarious avicularia present, the mandible greatly widened distally and rounded. Ovicells vestigial, the embryo large when fully developed, and lying mainly in the body-cavity. Rootlets as in *R. cornea*, but their walls less thickened at their commencement.

R. schönaui closely resembles *R. cornea* in general appearance, the zoarium being spiral and reticulate. Most of the material consists of imperfect colonies, but this species appears to differ from *R. cornea* in having a much flatter spiral. The frond is nearly discoidal, not cup-shaped, the distal whorls lying almost horizontally on their predecessors, but arranged otherwise as in that species. The largest colonies are about 54 mm. in diameter. Other distinguishing features were pointed out by LEVINSEN. The fenestrae are usually wider than the branches which separate them, and are pointed distally. LEVINSEN, who described the avicularia, found only two of them, neither with a complete mandible. Avicularia (fig. 2) are present in specimens from all the Siboga Stations, though varying in their frequency. The mandible is narrow at its base, expanding greatly to form a wide spatula of rounded form. Avicularia may be found in any part of the colony, but they often occur in an axillary position, or close to an axillary kenozooecium, on the proximal side of a fenestra. The rootlets have the same structure as in *R. cornea*, but are more delicate and are not conspicuously annulated proximally. The zooecia are on the whole longer and narrower than in the other species.

The feature by which the two species can be most easily distinguished is the ovicell, which is vestigial in *R. schönaui* (fig. 2). In the young fertile zooecium a large spherical vesicle makes its appearance in the region of the operculum, its distal part projecting into the vestigial ovicell (*Cf.* HARMER, 1902, p. 301, and Miss ROBERTSON, 1921), but I have not ascertained its morphology. A minute ovary occurs at the proximal end of the zooecium, close to the basal wall. The vesicle, or ovisac, which appears to have a complete spherical wall, is later found to contain a small embryo. Its wall becomes thickened, and is probably a secretory epithelium, providing nutriment for the developing embryo, which increases greatly in size and become filled with yolk. In its final form the ovisac reaches the full width of the zooecium, and with its embryo, which fills its cavity, it occupies nearly two thirds of the fertile zooecium, its distal end continuing to lie in the vestigial ovicell.

The comparison of *R. cornea* and *R. schönaui* suggests an explanation of the significance of vestigial ovicells in general. In *R. cornea* the ovicell is large enough to contain the whole embryo. In *R. schönaui* the embryo contains a large amount of yolk, so that the ovicell would be quite incapable of receiving it completely, even if it were as large as in *R. cornea*. The

reduction of the ovicell has probably been induced by the supply of an increased amount of nutrient yolk to the embryo. The ovicell having become incapable of containing so large an embryo, it no longer develops completely, although the reception by the vestigial structure of the distal end of the ovisac is an indication of its evolution. Similar differences between allied species are refered to below, in the Farciminariidae.

3. *Retiflustra reticulum* (Hincks). (Pl. XV, figs 1, 4).

Flustra reticulum Hincks, 1882, AMNH, 5, X, p. 163, Pl. VII, figs 4—4*b*. Victoria.
Flustra reticulum Kirkpatrick, 1888, AMNH, 6, II, p. 13. Victoria; — 1890, TS, p. 611. Torres Straits.
Flustra reticulum Waters, 1896, JRMS, pp. 281 *et seq.*, 289, Pl. VII, figs 27, 28; Pl. VIII, figs 10, 11, 21.
Carbasea reticulum MacGillivray, 1885, PRSV, XXI, p. 109, Pl. IV, figs 2, 2*a*. Victoria.
Retiflustra reticulum Levinsen, 1909, MSSB, p. 129, Pl. XXII, figs. 1*a—c*.

272. C. Stat. {60.\ 303.} Haingsisi, Samau Id, W. Timor, 0—36 M.
38. Q. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
125. A. Stat. 164. W. of N. end of New Guinea, 32 M.
198. E. Stat. 274. Off Jedan, Aru Is, 57 M.
259. B.\ 415. A. Stat. 318. Off Kangeang Id, N. E. of E. end of Java, 88 M.
262. E. Stat. 319. Java Sea, 82 M.
264. B. Stat. 320. Java Sea, 82 M.
266. A. Stat. 321. Java Sea, 82 M.

Cambridge, Mus. Zool.: —

Torres Straits, 95. A. C. HADDON, Reg. Feb. 24, 1898.
BM Victoria, T. HINCKS, Reg. May 13, 1899.

Branches comparatively narrow, rarely forming an anastomosis, bordered by a narrow margin of kenozooecia, except at the axils, where there is a large, more or less triangular kenozooecium, which may give rise to a rootlet, resembling those found in the preceding species. Zooecia (in Siboga specimens) elongate, as a rule not wider at the middle, the aperture occupying practically the entire front. Basal wall variably calcified, usually with a median uncalcified region, as in *R. cornea*. Avicularia large, vicarious, the calcareous bar complete, the proximal opesia long and triangular, the rostrum and mandible broad and spatulate, widening towards the distal end. Ovicells large, longer than wide, or wider than long, the proximal margin greatly thickened and passing at each side into a bluntly triangular lobe.

The Siboga specimens have long zooecia, not wider at the middle, as is usual in those from Victoria, in which the mandible is relatively small, with parallel margins, not widening distally; and the tentacles, as well as the septal lines of the frontal surface, are pigmented; — features which are not found in the Malay specimens. In spite of these differences it seems difficult to separate the Siboga specimens from HINCKS' species. I have found no trace of the spines described by MACGILLIVRAY and KIRKPATRICK in Victorian specimens. WATERS (1896, p. 289, Pl. VIII, fig. 10) describes them as prolongations of the marginal kenozooecia. MACGILLIVRAY (Pl. IV, fig. 2*a*) shows them as much branched, and KIRKPATRICK (1888) named this form var. *dorsitecta*, but without referring to the earlier description.

LEVINSEN placed this species, I think correctly, in *Retiflustra*. The septula, which have been described by WATERS, are like those of the preceding species, being uniporous and arranged in a transverse row on the terminal wall, sometimes bending frontally at its two ends; and forming a longitudinal row, consisting of a number of pores, on the lateral wall. The affinity to other species of the genus is shown by the identical character of the rootlets, which are delicate, very long and broad, cylindrical tubes, each given off by an axillary kenozooecium, and terminating in a tuft of hair-like, lateral branches for attachment. The ovicell (fig. 1) agrees with those of Victorian specimens, the thickened proximal margin, ending in blunt triangular lobes, being characteristic. While the ordinary zooecia have a slightly curved distal wall, as seen in basal view, the distal wall of the fertile zooecium is angularly bent and projects distally for some distance along the basal wall of the ovicell. LEVINSEN stated that there is no distal wall and that there are no distal septula, in the fertile zooecia. This is not correct for the Siboga specimens, in which a normal row of distal pores occurs in the fertile zooecium, specially well seen in 125. A. In other cases the distal wall, though reduced, is distinguishable; and I have found it in HINCKS' Victorian specimen. The ovicells are variable in shape, being longer than wide (fig. 4), or wider than long (fig. 1). The triangular proximal opesia of the avicularium, largely concealed by the mandible in fig. 4, has a well developed longitudinal row of parietal muscles on each side.

Fam. 4. ONYCHOCELLIDAE.

Onychocellidae Jullien, 1882, BSZF, VI, p. 276.
Onychocellidae Canu, 1900, BSGF, 3, XXVIII, p. 385.
Onychocellidae Canu and Bassler, 1917, USNMB, 96, p. 25; — 1920, USNMB, 106, p. 204.

This Family was introduced by JULLIEN for forms with a well developed cryptocyst, a small opesia, inconspicuous ovicells and vicarious avicularia, which he termed "onychocellaires", of peculiar type. Eight genera were proposed by him at the same time, distinguished largely by the shape of the zooecia; the majority of the species being Cretaceous. Four of his genera include recent species; but of these it is unnecessary to consider *Ogivalia* and *Floridina* in the present connexion. CANU and BASSLER regard the Onychocellidae as a Subfamily of the Opesiulidae; but the group seems to deserve Family rank.

WATERS (1883, QJGS, XXXIX, p. 425; — 1891, *Ibid.*, XLVII, p. 8) has refused to accept more than one of the genera, *Onychocella*, of those introduced by JULLIEN, whom I follow in regarding *Onychocella* and *Smittipora* as distinct.

The structure of various species of this Family has been described specially by JULLIEN (*op. cit.*), NORDGAARD (1907, BMA, N° 2, p. 10) and LEVINSEN (1909, MSSB). On pp. 11, 292, LEVINSEN described separate proximal and distal walls in *Onychocella* [1]) a presumed primitive feature; whereas in other Cheilostomes a single terminal wall was stated to be at once the proximal and distal wall of adjoining zooecia. For the rosette-plates see his p. 23; operculum, pp. 37, 45; avicularium and mandible, pp. 47—49, ovicell, p. 59; and special description, p. 153.

1) His descriptions appear to be based principally on *Smittipora*; *cf.* my synonymy of *S. abyssicola*.

1. Onychocella Jull.

Onychocella Jullien, 1882, *op. cit.*, p. 277.
Genotype, selected by CANU (1900, *op. cit.*, p. 388), *Cellepora angulosa* Reuss, 1847.

Zooecia more or less hexagonal. Cryptocyst extensive, depressed, not differentiated from an oral shelf, extending round the distal border of the orifice. Opesia reduced to little more than the orifice, with straight or curved sides, often trifoliate; the opesiules open, sometimes indistinct. Avicularia vicarious, asymmetrical, with a well developed rostrum, the cryptocyst with an undivided opesia, the mandible with a membranous expansion on one side only. Ovicells entozooecial, very inconspicuous.

According to LEVINSEN (*op. cit.*, p. 11), the genus commences in the Jurassic and attains its maximum in the Cretaceous; while it commonly occurs in the Tertiary and persists as a recent genus.

The synonymy of the type-species is involved, and it is not agreed whether the recent *O. antiqua* is identical with it. The original figure (Miocene) of REUSS (1847, Pl. XI, fig. 10) is small and unsatisfactory. In 1869 he gave better figures (Pl. XXIX, figs 9—11) of fossils from the Oligocene which he referred to the same species. He mentioned (p. 253) "kleine Zellen", which seem to have been avicularia; but in a later account (1874, Pl. X, fig. 13) one of these (Miocene) is figured and does not altogether resemble the avicularium of *O. antiqua*. On the other hand the figure (Pliocene) of Manzoni (1875, Pl. I, fig. 11) agrees with that species both in its avicularia and in the form of the opesia. It cannot be assumed that all the fossils recorded as *O. angulosa* belong to the same species, but it seems best to accept the name provisionally for the recent species. The literature is extensive, and the subjoined synonymy is by no means complete.

1. *Onychocella angulosa* (Reuss). (Pl. XVI, figs 8, 9).

Fossil.

Cellepora angulosa Reuss, 1847, FPWT, p. 93, Pl. XI, fig. 10.
Membranipora angulosa Reuss, 1869, DAWW, XXIX, pp. 253, 262, Pl. XXIX, figs 9—11; — 1874, DAWW, XXXIII, p. 185, Pl. X, figs 13, 14.
Membranipora angulosa Manzoni, 1875, BPC, p. 8, Pl. I, fig. 11.
Membranipora angulosa Waters, 1878, TMGS, XIV, p. 468.
Onychocella angulosa Waters, 1891, QJGS, XLVII, p. 9.
Onychocella angulosa Neviani, 1900, PI, VI, p. 160.
Onychocella angulosa Canu, 1904, BTT, p. 18, Pl. XXXIV, fig. 20 (from MANZONI, 1875); — 1917, BSGF, 4, XVII, p. 352.
Onychocella angulosa Faura Sans and Canu, 1916, BTTC, p. 70.
Onychocella angulosa Canu and Bassler, 1920, USNMB, 106, p. 205, Pl. XXXII, figs 31, 32.

Recent.

Membranipora antiqua Busk, 1858, QJMS, VI, p. 262, Pl. XX, figs 1, 2. Madeira.
Membranipora antiqua Hincks, 1880, AMNH, 5, VI, p. 88, Pl. XI, fig. 7.
Membranipora angulosa Waters, 1879, AMNH, 5, III, p. 122, Pl. XIII, fig. 3. Naples; — 1885, JRMS, 2, V, p. 778, Pl. XIV, fig. 42 (mandible).
Onychocella antiqua Jullien, 1882, BSZF, VI, p. 279. Madeira.
Onychocella marioni Jullien, 1882, *t. cit.*, p. 277, text-fig. Nice, Marseille, Cape Verde Is.

Onychocella antiqua Hincks, 1891, AMMH, 6, VIII, p. 91.
Onychocella antiqua Thornely, 1905, PGM, p. 111 (name only). Ceylon.
(nec *Mollia antiqua* Smitt, 1873, KVAH, XI, N° 4, p. 12, Pl. II, fig. 73; which is the genotype of *Floridina* Jullien, 1882, *t. cit.*, p. 283).
Smittipora antiqua Kirkpatrick, 1890, AMNH, 6, V, p. 16 (name only). China Sea, 27—36 fath.
Onychocella angulosa Waters, 1898, JLS, XXVI, pp. 661, 670, 689.
Onychocella angulosa Calvet, 1902, TIZM, 12, p. 14. Corsica; — 1907, BTT, p. 391.
Onychocella angulosa Norman, 1909, JLS, XXX, p. 293, Pl. XXXVII, fig. 1. Madeira.
Onychocella angulosa Marcus, 1921, IPBS, p. 8. Java Sea.

It will be seen from the above synonymy that *O. angulosa* has been recorded as a recent species from Ceylon and the China Sea, in addition to other localities, principally in the Mediterranean and in the Atlantic.

390. D. Stat. 99. North Ubian, Sulu Archipelago, 16—23 M.

Cambridge, Mus. Zool.: —

BM Japan, 11. D, 45. A, A. Owston, Reg. June 23, 1902.
Japan, K. Mitsukuri, Reg. Sept. 23, 1896.

British Museum: —

China Sea, 89. 8. 21. 49.
Madeira, 99. 7. 1. 982, Busk Coll. (Type of *Membranipora antiqua*).

Encrusting. Zooecia more or less hexagonal, the edges little raised. Cryptocyst depressed, concave, covered uniformly with minute pearly granules. Opesia frequently with distinct opesiules; usually trifoliate. Avicularia with a long rostrum curving round a zooecium, the opesia oval, usually wider distally. Mandible with a long, sharply edged, narrow portion, formed by the united halves of the main sclerite, strongly incurved at the tip, bearing a membranous expansion on the side turned away from the associated zooecium.

The Siboga specimen (in spirit) has a bright orange-red colour. Young zooecia are separated from one another by a sharp edge; but with further calcification the edges of contiguous zooecia develop independently, and may then be separated by wide grooves (see above, p. 255). The cryptocyst is uniformly concave, so as to form a shallow cup. The proximal lip of the opesia is slightly convex distally, its median portion more elevated than its lateral parts. Owing to the presence of distinct opesiules the opesia is trifoliate (as stated by Busk and Hincks, 1891) in the Siboga specimens. Opesiules are not distinct in the type-specimen of *O. antiqua* (Busk), from Madeira, in the British Museum (99. 7. 1. 982); but they are either distinct or indistinct in others from the same locality presented by Canon A. M. Norman to the Cambridge collection (Reg. July 3, 1907, 18). The ovicells, two of which are shown in fig. 8, have the form figured by Levinsen (1909, Pl. XXII, fig. 3 a) in another species, described by him as *Onychocella* sp., but apparently referable to *Smittipora abyssicola* (*q. v.*). The opesia of the fertile zooecium is often larger than that of the ordinary zooecia, but this feature is more obvious in specimens from other localities than in my figure.

In the specimen shown in fig. 8, the edge of the avicularian rostrum is double on each side, but this is the result of secondary calcification, and the edge is single in other avicularia. The avicularian opesia is oval, usually narrower at the proximal end. A small median tubercle, probably a sense-organ, occurs on the membrane closing the opesia, just proximally to the base

of the mandible (*Cf.* WATERS, 1898, p. 689). In an earlier paper (1885, p. 778, Pl. XIV, fig. 42), WATERS described a "thick lunate chitinous mass" on either side of the base of the mandible. I have observed this structure in the present species and in both species of *Smittipora* described below, most distinctly in *S. cordiformis*. It appears to be a thickening of the "chitinous line" separating the avicularium from the adjacent zooecium, and it probably has some relation to the movements of the mandible.

The mandible (fig. 9) constitutes the most distinctive feature of this species. Its proximal end is produced into two sharply triangular lobes, from which the two halves of the main sclerite start. At first separated by a fenestra of thinner chitin, they soon unite into a linear sclerite of some depth, forming a knife-edge basally. This appears to close against the convex edge of the avicularium, forming an effective pair of scissors. The tip is incurved, in the plane of the linear portion, sometimes more so than in the figured specimen, where it is displaced to one side by the pressure of the cover-glass. I have not been able to detect teeth on the edge of the linear part, as described by JULLIEN (1882, p. 275).

The opercula resemble those of *Smittipora*, described below. There is a well marked submarginal sclerite, but no distinct basal sclerite. The deep side is produced into the usual Membraniporine triangular flange, on either side.

A short distance from the base of the operculum, on its proximal side, and slightly outside it, is a sharply marked sclerite, into which the depressor muscle is inserted, on either side. This sclerite is a minute circle, but it seems to be prolonged distally as a line on the outer side of the proximal part of the operculum.

2. Smittipora Jull.

Smittipora Jullien, 1882, BSZF, VI, p. 284.
Smittipora Canu, 1900, BSGF, 3, XXVIII, p. 407.
Smittipora Canu and Bassler, 1920, USNMB, 106, p. 225.
Rectonychocella Canu and Bassler, 1917, USNMB, 96, p. 25; — 1920, *op. cit.*, p. 209.
Velumella Canu and Bassler, 1917, *op. cit.*, p. 26; — 1920, *op. cit.*, p. 213.
Genotype, indicated by JULLIEN, *Vincularia abyssicola* Smitt, 1873.

Zooecia, cryptocyst, opesia and ovicells as in *Onychocella*. Avicularia vicarious, symmetrical, without distinct rostrum, the opesia undivided. Mandible symmetrical, with a large membranous expansion on each side of the rhachis.

HINCKS (1891, AMNH, 6, VIII, p. 91) united *Smittipora* with *Onychocella*, maintaining that the occurrence of membranous expansions on either side of the rhachis of the mandible is not a sufficient generic distinction.

In 1917 CANU and BASSLER introduced three new genera, *Rectonychocella, Velumella* and *Diplopholeos*; and in the diagnosis of all three occurs the statement that "the retractor muscles of the polypide are attached in the median axis of the zooecium". This conclusion may be understood by reference to another paper by the first author (1917, BSGF, 4, XVII, p. 353), where it is stated that "Les indentations latérales ou *opésiules* sont rarement symétriques [in *Onychocella angulosa*], car les fibres rétracteurs du polypide s'insèrent rarement dans l'axe médian de la zoécie". The opesiules are passages, however, for the transmission of the depressor muscles

(Harmer, 1902, QJMS, XLVI, pp. 316, 331), and it is no more than an assumption to state that their symmetry is affected by the position of the retractors (see also p. 215).

The genotype of *Rectonychocella* is *Onychocella solida* Nordgaard (1907, BMA, N° 2, p. 8); and that of *Velumella* is *Onychocella* sp. Levinsen (1909), re-named by Canu and Bassler *V. levinseni* (see synonymy of *Smittipora abyssicola*). Both are recent species, with mandibles resembling those of *Smittipora* in having a membranous expansion on each side. *Diplopholeos* was founded on a fossil, in which the mandibles are naturally unknown. On subtracting the characters common to *Rectonychocella* and *Velumella* from the diagnoses, the only features which seem to separate them are certain differences in the extent and denticulation of the avicularian opesia, and in the continuity or otherwise of the "mural rim" with the horizontal cryptocyst. In their later work (1920) Canu and Bassler use this latter character in their diagnosis of *Smittipora*; accepting that part of Jullien's diagnosis which stated that the cryptocyst possesses three distinct facets, one of which is the horizontal cryptocyst and the other two are the oblique lateral walls.

The British Museum collection includes a specimen of *Smittipora* from St Vincent, W. Indies (40. 10. 23. 22). Its cryptocyst has the arrangement described by Jullien and by Canu and Bassler; and, taking into account its occurrence in the neighbourhood of Cuba and Florida, from which Smitt's type-material was obtained, I can hardly doubt that it belongs to his species, *S. abyssicola*. Its agreement with the Eastern specimens described below is very close. The opesiules are indeed somewhat more contracted than in the specimen shown in fig. 10, an arrangement associated with a prolongation of the outer parts of the median process beneath the opesiules, which are reduced to oblique slits converging towards the middle line of the zooecium. But I find the same arrangement in the Queensland specimen mentioned below, under *S. abyssicola*; and in some of the Eastern specimens the mural rim is almost as distinct from the horizontal cryptocyst as in the one from St Vincent, even though other zooecia in the same colonies have these parts continuous. The mandibles of the St Vincent specimen are similar to those shown in Fig. 12. I feel confident that the Siboga specimens are not distinguishable from Levinsen's unnamed species which was made the type of *Velumella*; and I do not find that the avicularian opesia is "entirely denticulated", which was one of the distinguishing characters of that genus. I am thus obliged to regard both *Velumella* and *Rectonychocella* as synonyms of *Smittipora*.

Key to the Eastern species of *Smittipora*.

Opesiules distinct. Membranous expansions of mandible extending at least two thirds of its length; its rhachis toothless or with a few teeth distally — 1. *S. abyssicola*.

Opesiules not distinct. Membranous expansions of mandible not extending much beyond the proximal half; its rhachis toothed along its whole extent — 2. *S. cordiformis*.

1. *Smittipora abyssicola* (Smitt). (Pl. XVI, figs 10—13).

Vincularia abyssicola Smitt, 1873, KVAH, XI, N° 4, p. 6, Pl. I, figs 60, 61. Cuba, 450 fath.; Florida, 68 fath.

Smittipora abyssicola Jullien, 1882, BSZF, VI, p. 284.

(?) *Smittipora abyssicola* Ortmann, 1889, ANG, LVI, 1, p. 31. Pl. II, fig. 12. Japan.

Onychocella abyssicola Thornely, 1905, PGM, p. 111 (name only). Ceylon.

Onychocella sp. Levinsen, 1909, MSSB, p. 153, Pl. XXII, figs 3*a*—*d*; and, apparently, Pl. XIX, fig. 14*a* and Pl. XXIV, fig. 10.
Velumella levinseni Canu and Bassler, 1917, USNMB, 96, p. 26; — 1920, USNMB, 106, p. 214.
Smittipora abyssicola Canu and Bassler, 1920, USNMB, 106, p. 225.

323. D. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
409. B. Stat. 60, 303. Haingsisi, Samau Id, W. Timor, 0—36 M.
420. B. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
395. B. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M. (and on other slides from the same Station).
131. H. Stat. 164. W. of N. end of New Guinea, 32 M.
348. E. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
377. B. Stat. 240. Banda, Banda Sea, 9—45 M.

Cambridge, Mus. Zool.: —

Singapore, off Pulu Senang, 10 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.
Ceylon, Miss L. R. THORNELY, Reg. Apr. 25, 1906, 18.
Queensland, Holborn Id. (W. A. Haswell Coll.), Australian Museum, Reg. Oct. 23, 1899.

British Museum: —

Torres Straits, "Alert" Voyage, 82. 2. 23. 485—489.

Encrusting. Zooecia more or less hexagonal, the mural rim distinct from or continuous with the horizontal cryptocyst, which bears large tubercles. Opesiules distinct, sometimes reduced to oblique slits, floored by lateral extensions of the median process. Avicularia large, symmetrical, without distinct rostrum; the opesia large, wider distally, its edge more or less denticulate. Mandible cordiform, with a very large membranous expansion on each side, extending at least two thirds of the length of the rhachis. Ovicells inconspicuous, the opesia of a fertile zooecium larger than that of the ordinary zooecia.

In the Siboga specimens the cryptocyst is for the most part uniformly concave, without angular depressions between its horizontal and lateral parts. The cutting edge of the rhachis of the mandible bears a few rather large, irregular teeth, near its distal end (fig. 12). Ovicells are commonly present, and two are represented in fig. 10. I have no independent obervations on their structure, but reference may be made to LEVINSEN's diagrammatic figure (1909, Pl. XXIV, fig. 10) and to his fig. 3*a* on Pl. XXII, showing their external form. The opesia of a fertile zooecium is usually larger than that of other zooecia, as indicated in my fig. 10, where it will be seen that it is wider proximally than distally, a feature which is less marked in ordinary zooecia. A young colony on slide 395. C[1] (a Lepralioid species) consists of two avicularia and four zooecia, of which the ancestrula does not differ materially from the others.

2. *Smittipora cordiformis* n. sp. (Pl. XVI, figs. 14—18).

Vincularia abyssicola Hincks, 1881, AMNH, 5, VII, p. 155, Pl. X, fig. 4. Singapore or Philippines, Miss E. C. JELLY.
(?) *Smittipora abyssicola* Hincks, 1884, AMNH, 5, XIII, p. 358; — 1887, JLS, XXI, p. 130. Mergui Archipelago, Burma.
(?) *Micropora abyssicola* MacGillivray, 1891, PRSV, N. S., III, p. 80, Pl. IX, fig. 4. N.W. Australia.

323. H. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
Type. 364. C. Stat. 71. Makassar, S. W. Celebes, 0—32 M.

British Museum: —

Singapore or Philippines. Hincks Coll., 99. 5. 1. 738, 739 (Miss E. C. JELLY).
Mergui, Burma. Dr. ANDERSON, 85. 12. 29. 3.
Amirante Is, "Alert" Voyage, 82. 10. 18. 88—95 and 141—142.

Encrusting. Zooecia more or less hexagonal, the edge little projecting. Cryptocyst depressed, concave, its tubercles as in *S. abyssicola*. Opesia without distinct opesiules, a conspicuous median tubercle usually present within its distal border. Avicularia of moderate size, symmetrical, without distinct rostrum; the opesia undivided, pear-shaped, its edge denticulate. Mandible cordiform, its membranous expansions not extending much beyond the proximal half; its rhachis toothed basally along its whole length. Opesia of the fertile zooecium much larger than those of ordinary zooecia, subtriangular.

S. cordiformis, so named from the shape of the mandible (fig. 17), differs from *S. abyssicola* in the following respects. The opesia has no distinct opesiules, its lateral sides being parallel. A distinct tubercle on the distal wall (fig. 14) usually occurs within its borders. The opesia of the fertile zooecium, which is much larger than in the ordinary zooecia, is subtriangular (fig. 15). The opercula are brown, and of thicker texture than in *S. abyssicola*. The mandible (fig. 17) is more cordiform than in that species, its membranous wings shorter, and not extending much beyond the proximal half, while they are relatively broader, with more convex sides. The two halves of the main sclerite converge towards one another less sharply than in the other species, this feature being readily observed in a dry mount; and the rhachis, which is compressed distally, is distinctly toothed along its whole length. Its sclerites are black in old specimens.

As in the other species, the operculum (fig. 18) has no basal sclerite, but is uniformly chitinised, except for the thicker, dark brown, marginal sclerite, and it is thus sharply outlined from the adjacent frontal membrane. As in the other Onychocellidae examined, the chitin surrounding the operculum is somewhat thickened and forms a definite chitinous frame. In *S. cordiformis*, *S. abyssicola* and *Onychocella angulosa*, I have distinguished a small, linear depressor sclerite, projecting vertically into the hypostegia, for the insertion of the corresponding muscle, just proximally to the base of the operculum, on each side.

The ovicell appears to be merely a slight inflation of the distal wall of the zooecium, with which its cavity is continuous. This is probably characteristic of the Onychocellidae in general, in agreement with LEVINSEN's account (1909, Pl. XXIV, fig. 10), referring to *S. abyssicola*.

Fam. 5. LUNULARIIDAE.

Lunulitidae (pars) auctt.
Selenariidae (pars) auctt.
Lunulitinae Gregory, 1893, TZS, XIII, p. 224.
Lunulariidae Levinsen, 1909, MSSB, p. 155.

Free, discoidal Cheilostomata, saucer-shaped or conical and Trochiform, are known in considerable numbers, both fossil and recent; and their systematic position is difficult to determine. Leaving on one side *Conescharellina* and its allies, referable to the Ascophora, there remain

many which belong to the Anasca. The recent species of this series were united by Busk (1854, BMC, p. 97) in a Family Selenariadae, under the genera *Cupularia*, *Lunulites* and *Selenaria*. Gregory (1893, pp. 223, 224) broke up this Family into two Sub-families; — (1) Lunulitinae, Membraniporidae, and (2) Selenarinae, Microporidae.

Lunulites was introduced by Lamarck (1816, ASV, p. 194) for two new fossil species, *L. radiata* and *L. urceolata*. Both were further described and figured by Lamouroux (1821, EM, p. 44, Pl. LXXIII, figs 5—8 and 9—12), who stated that he would have established a genus "Cupulaire", for *L. urceolata*, if he had not been reluctant to multiply too much the divisions. In 1839 [1]) Ehrenberg (Abh. ph.-Kl. K. pr. Ak. Wiss., 1838 (1840), Tab. facing p. 120) defined *Cupularia*, which he placed in close association with *Lunulites*, but he mentioned no species, and he gave no indication whether his name was a new one or not. In 1840, F. A. Roemer (Verstein. norddeutsch. Kreidegebirges, 1, p. 15) mentioned *Cupularia* Lamouroux, placing under it a single species, *C.* (*Lunulites*) *Münsteri* v. Hag. D'Orbigny (1853, PFTC, p. 511) seems to have been the first author who definitely uses *Cupularia* in the sense intended by Lamouroux, stating explicitly, however, that he refers to *Lunulites urceolata* Lamx (*non* Lamk). It appears to me legitimate to assume that *Cupularia* was used by Ehrenberg as a Latinised form of the "Cupulaire" of Lamouroux (though this is not certain), in which case, although the genus should be attributed to Ehrenberg, 1839, its genotype would be *L. urceolata* Lamx, leaving *L. radiata* Lamk as the genotype of *Lunulites*.

Busk (1884, Chall., p. 208) proposed *Lunularia* for the recent *Lunulites capulus* Busk (1852, VR, Pl. I, figs 13, 14; — 1854, BMC, p. 100), introducing it as *Lunulites* Lamx, "*nomen mutatum*". From his statement that *Lunulites* is more suitable for fossil forms, his intention was evidently to suggest a new genus for the recent species; and it thus follows that *L. capulus* is the genotype of *Lunularia*, as is expressly stated by Canu and Bassler (1917, USNMB, 96, p. 30). The same authors (1919, CIW, 291, p. 77) have also introduced *Cupuladria*, selecting as the genotype *Cupularia canariensis* Busk (1859, QJMS, VII, p. 66), a recent species.

The descriptions of Lamarck and Lamouroux contain no information with regard to vibracula, and even the zooecial characters were indicated in insufficient detail. In view of the inadequacy of the accounts of these authors, there are great advantages in accepting, for the recent species, both *Lunularia* and *Cupuladria*, genera which are more definitely defined by the characters of their respective genotypes.

If *Lunularia* (not represented in the Siboga Collection) is accepted for recent species, Levinsen's Family follows as a matter of course. Gregory's separation of the Selenariidae (as Selenarinae) seems to be justified by the striking difference between the vibracula of this group and those of the Lunulariidae. The difficulties in classification are by no means exhausted, however, by this separation. Among the Selenariidae (see below) the frontal wall may be that of the Microporidae, the cryptocyst being extensive and furnished with opesiules, and the operculum filling the orifice, as in that Family. But other species which have the same type of vibraculum are practically Membraniporine in these respects. The Lunulariidae, on the other hand, are usually Membraniporine in the characters of their frontal surface, but *Cupularia lowei*

1) See C. D. Sherborn's invaluable "Index Animalium", 1922—, p. 1694.

(Gray MSS.) Busk (see Norman, 1909, JLS, XXX, p. 290) is practically Microporine. Levinsen (1909, MSSB, p. 155) suggested that this species should be referred to the Microporidae, and Waters (1921, JLS, XXXIV, p. 412) indicated that it might be removed to a distinct genus. He stated that bundles of muscles pass to the frontal membrane through the pores which traverse the sides of the cryptocyst; and these are no doubt typical parietal muscles. The morphology of the longitudinal row of muscles which, according to the same author, "pass from the lower surface of the zooecial chamber to the lower surface of the zoarium" is more obscure.

It is impossible not to be struck by the resemblance of *Setosella* Hincks, usually referred to the Microporidae, to the Microporoid forms of the Selenariidae, in Busk's original sense; and of *Setosellina* Calvet (see below) to the Membraniporine forms. It appears necessary to assume that the Selenariiform habit has been acquired independently in the two genera. Both are provided with typical vibracula, resembling those of the discoidal species, and they may respectively represent the original encrusting species which have given rise to the free form of colony. This is not so improbable as might appear at first sight. It has frequently been pointed out (see Waters, 1921, JLS, XXXIV, p. 401) that the Selenariiform colonies commence their growth by encrusting a small grain of sand, or some similar object, which is later included in the zoarium. Fixation on so small an object almost necessitates the assumption of a discoidal shape, if growth is continued in a radial direction.

The mode of life of Selenariiform colonies is uncertain, though various statements on the subject are current. Busk (1854, BMC, pp. 104, 106) suggested that the vibracula might be "subservient to locomotion"; and Hincks (1880, BMP, p. 181 n.) stated that he had been informed by Mr Busk of the confirmation of this conjecture by actual observation. I have failed to find any description of these observations. Faura Sans and Canu (1916, BTTC, p. 69) state that "Nous avons déjà établi que les vibraculaires sont des organes de stabilisation zoariale et que tous les *Lunulites* vivaient la pointe en bas sous les frondes des algues". It would be interesting to have a fuller account of the evidence on which these statements are based. Maplestone (1910, PRSV, XXIII, p. 3) had already expressed the opinion that the conical forms (*Conescharellina*[1]) live with their base uppermost, and he quoted an important statement by Whitelegge, who had living specimens of *C. philippinensis* under observation for three days, that from them "there extended fine filaments, half an inch long, attached in some cases to tubes of Annelids and fragments of shell.... This affords a clue to the manner in which the conical forms manage to live with their bases upwards". Waters (1921, JLS, XXXIV, p. 406) refers to this account and to my own observations on rootlets (1909, BAAS, Dublin Meeting, 1908, p. 723). These were made on species of discoidal (or conical) Ascophora in the Siboga Collection, and I have been unable to find similar structures in the Anascous Selenariiform species.

I think that *Setosellina* should be placed definitely in the Lunulariidae, which would then consist of species, either encrusting or Selenarian, with vibracula usually alternating with the zooecia in the same longitudinal rows, their opesia not reduced by a calcified lamina, with an aperture occupying practically the entire front of the zooecia, which have a well developed cryptocyst, and with or without ovicells.

1) See also Livingstone (1924, 1925, RAM, XIV, pp. 205—212 and 301—305) for this genus.

1. Setosellina Calvet.

Setosellina Calvet, 1906, BMHN, XII, p. 157; — 1907, BTT, p. 395.
Setosellina Canu and Bassler, 1920, USNMB, 106, p. 111, text-fig. 27 E (p. 109).
Ellisina (pars) Norman, 1903, AMNH, 7, XI, p. 596.
Monotypical. Genotype, *S. roulei* Calvet, 1906, p. 157; — 1907, p. 395, Pl. XXVI, figs 5, 6. Cape Verde Is.

Aperture occupying practically the entire front, the gymnocyst absent or evanescent. Cryptocyst narrow but well developed, strongly tuberculate, without any marked proximal widening, extending round the entire opesia or evanescent distally. Opesia oval or widened proximally. Vibracula vicarious, in the longitudinal rows of zooecia, one at the distal end of each zooecium, the opesia asymmetrical, with its long axis in the line of the rows or more or less transverse. Pore-chambers present or wanting. Ovicells broader than long, with a small, median oval fenestra (in the type-species).

As originally introduced, *Setosellina*, so named from its resemblance to the Microporoid *Setosella* Hincks, was defined as having the main axis of its vibracular opesia in the same line as that of the zooecium. I think it necessary to modify this part of the diagnosis, in order to include *Membranipora coronata* Hincks. There seem to be reasons for placing this species in Calvet's genus, in spite of the fact that it has strongly developed pore-chambers. I cannot follow Norman (1903, AMNH, 7, XI, p. 596) in placing it in *Ellisina* (see p. 227).

Vibracellina Canu and Bassler (1917, USNMB, 96, p. 14; — 1920, USNMB, 106, p. 110) has its vibracula scattered in the zoarium, not alternating with the zooecia in the longitudinal rows; but in other respects it hardly differs from *Setosellina*. *Vibracella* Waters (1891, QJGS, XLVII, p. 10), is referable to the Onychocellidae. *Heliodoma* Calvet (1906, BMHN, XII, p. 157; — 1907, BTT, p. 396) differs in its spiral growth, in the position of the vibracula, which alternate quincuncially with the zooecia, and in its more highly developed cryptocyst. These genera, with the exception of *Vibracella*, seem to be allied to one another and to *Cupuladria* (Lunulariidae) and they appear to represent a stage intermediate between Membraniporidae and the free discoidal forms.

1. *Setosellina constricta* n. sp. (Pl. XVI, fig. 1).

Type. 40. E. / 41. B. } Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
396.W. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
376. M. Stat. 213. Saleyer, S. of Celebes, 0—36 M.

Encrusting small stones, etc., minute (not exceeding 3 mm. in diameter), more or less discoidal. Ancestrula surrounded by about 7 zooecia, not differing from them in character. Zooecia distinct, separated by narrow grooves, expanded at the angles; their edges slightly raised. Proximal gymnocyst present or evanescent; aperture occupying nearly the entire surface. Cryptocyst slight, about equally developed proximally and laterally, becoming evanescent distally, bearing transverse crenulations. Distal part of opesia generally separated from the proximal part by a constriction, which is not always present. Vibraculum globular, most of its frontal surface occupied by the opesia, which is constricted at the middle by two teeth, one slightly larger than the other. Seta long, fine, its tip incurved. Pore-chambers apparently wanting. Ovicells not found.

S. constricta is nearly related to the type-species, from which it is distinguishable by its more elongated and less regularly oval opesia, by the fact that the cryptocyst does not run evenly round the whole of the opesia, and by the relatively large vibracular opesia. It might be supposed to be merely a young stage of *Cupuladria guineensis*, but this seems to be negatived by the following considerations. The zoarium is encrusting, and frequently passes round the curved surfaces of the small stones, on which it grows, towards their lower surface. If it were a *Cupuladria* it might be expected to continue its growth in a horizontal direction, and to show indications of assuming a free, discoidal form. The vibracular setae, which are hooked at the end, as in *C. guineensis*, are delicate and thin, like those figured in the type-species; and they are markedly finer than the short setae of the centrally placed vibracula of *C. guineensis*.

S. roulei was described by CALVET as having no ovicells; but, as pointed out by CANU and BASSLER (1920, USNMB, 106, p. 111), two of them are figured in his 1907 Memoir (fig. 5).

2. *Setosellina coronata* (Hincks). (Pl. XVI, figs 2—4).

Membranipora coronata Hincks, 1881, AMNH, 5, VII, p. 147, Pl. X, fig. 1. Singapore or Philippines; — 1882, AMNH, 5, IX, p. 118. Probably Ceylon.
Membranipora coronata Waters, 1898, JLS, XXVI, pp. 661, 669, 687, 689.
Membranipora coronata Kirkpatrick, 1890, TS, pp. 611, 615. Torres Straits.
Membranipora coronata Philipps, 1899, WZR, p. 440. Lifu, Loyalty Is.
Membranipora coronata Thornely, 1907, MPIM, p. 186. Indian Ocean.
Biflustra coronata MacGillivray, 1891, PRSV, N. S., III, p. 79, Pl. IX, fig. 3. W. Australia.
Ellisina coronata Norman, 1903, AMNH, 7, XI, p. 596.
Membranipora hastilis Kirkpatrick, 1890, AMNH, 6, V, p. 18. Pl. V, fig. 3. Macclesfield Bank, China Sea.
Membranipora hastilis Thornely, 1905, PGM, p. 110. Ceylon. — 1906, PGMC, p. 449; corrected to *M. coronata*.
nec *Membranipora coronata* Jullien, 1888, CH, p. 76 (*fide* WATERS, 1905, JLS, XXIX, p. 230).

88. D. Stat. 115. Kwandang Bay, N. Celebes, reef. On a coral.
396. X. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
130. E.) Stat. 164. W. of N. end of New Guinea, 32 M.
399. E.)

Cambridge, Mus. Zool.: —

BM Singapore, F. P. BEDFORD, Reg. Nov. 11, 1899.
Singapore, Dr. R. HANITSCH, Reg. June 19, 1900.
Ceylon, Miss L. R. THORNELY, Reg. Apr. 25, 1906.
BM Lifu, Loyalty Is, A. WILLEY (Miss E. G. PHILIPPS), Reg. Mar. 1, 1898.

British Museum: —

Macclesfield Bank, China Sea, 36 fath., 89. 8. 21. 62, type of *M. hastilis* Kirkp.

Encrusting. Zooecia large, without gymnocyst, the aperture occupying the entire front; spines wanting. Operculum with a distinct, semicircular, submarginal sclerite. Walls of zooecia highly calcified, the cryptocyst narrow but deep, strongly tuberculate, particularly at the sides of the opesia, which is oval or wider proximally. Pore-chambers extremely conspicuous, and about four in the distal half of the lateral wall, their openings to the zooecia often large. Ovicells probably wanting. Vibracula with the rostrum directed obliquely transversely, asymmetrical and spout-like. Seta strong, minutely serrate on one edge, usually greatly exceeding the zooecium in length, its tip incurved.

With one exception (130. E) among the specimens examined, the seta is longer than the zooecium (fig. 3), and is even longer than as figured by KIRKPATRICK (1890, CS, Pl. V, fig. 3). It is triangular at the base (fig. 4), the proximal part of the remainder being winged by a delicate flange on each side, not represented in the figure. At the distal end of the triangular part is a recurved barb, on the basal edge, while the remainder of this edge is furnished with a row of short, very fine, hair-like structures. The rostrum is asymmetrical (fig. 3), the opesia not divided by a calcareous bar, its proximal end pointed or rounded proximally, and occasionally trifoliate, the distal part spout-like, the two regions separated by a pair of condyles, of which the one further from the adjoining orifice is the more conspicuous.

In a single case I have found an embryo, lying in an ovisac, in the cavity of a zooecium which does not seem to differ from the others; and this justifies the surmise that ovicells are not developed. WATERS indeed states (1898, p. 661) that in his *M. coronata* group the ovicell is "small, globular or cucullate"; but on p. 669 he indicates that ovicells are unknown.

The distal pore-chamber leads into the avicularium (fig. 2), which has another pore on its distal side. Of the lateral chambers, four are usually seen on each side, the most distal one communicating with an avicularium, and the other three with the adjacent zooecium. In the young state the openings are widely open, but in the older condition they become more or less constricted, although some may remain wide.

2. **Cupuladria** Canu and Bassler.

Cupularia Levinsen, 1909, MSSB, p. 154.
Cupularia Busk, et auctt.
Cupuladria Canu and Bassler, 1919, CIW, 291, p. 77; — 1920, USNMB, 106, p. 103; — 1923, USNMB, 125, p. 28.
Genotype, indicated by the authors, *Cupularia canariensis* Busk, 1859, QJMS, VII, p. 66.

Zoarium free, discoid. Zooecia rhombic, in radial rows, a vibraculum at the distal end of each. Cryptocyst well developed, the opesia depressed, simply oval, or rounded, or quadrangular, sometimes invaded by processes from the basal margin of the cryptocyst. Ovicells probably wanting.

CANU and BASSLER state that there is no cryptocyst, but this structure is distinctly developed in the type-species.

The species of *Cupuladria* are usually provided with a Membraniporine opesia, into which calcareous denticles commonly project from the edge of the cryptocyst (*C. owenii* (Gray), see BUSK, 1854, BMC, p. 99, Pl. CXV). *C. lowei*, which appears to belong to a distinct genus (see p. 263), has a very different structure.

1. *Cupuladria guineensis* (Busk). Pl. XVI, figs 5—7, text-fig. 9).

Cupularia guineensis Busk, 1854, BMC, p. 98, Pl. CXIV, figs 1—5. New Guinea; — 1884, Chall., p. 206, Pl. XIV, figs 6—6*b*. Stat. 186, Torres Straits, 8 fath.; Philippine Is.
Cupularia guineensis Marcus, 1921, KVAH, LXI, N° 5, p. 8. Cape Jaubert (N. W. Australia, 19° S.), 12 fath.; 1921, IPBS, p. 8. Gaspar Straits, Singapore, W. Borneo.
Cupularia stellata Busk, 1854, *t. c.* p. 99, Pl. CXVIII, figs 1—4. Philippine Is. (young state of this species, *fide* MARCUS, IPBS).
(?) *Discoflustrella complanata* D'Orbigny, 1853, PFTC, p. 562. Straits of Malacca, recent.

488. A. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M. 26 colonies.

Zoarium (in Siboga specimens) a greatly flattened cone, reaching a diameter of about 9 mm., the height much less. Basal side concave, with an even surface, interrupted by very shallow, radial grooves between the rows of zooecia; and, near the periphery, by a slight radial groove in the middle of each row. This surface is imperforate, or with small pores. Margin of colony serrated by the projection of vibracula of alternate rows. Frontal surface slightly convex, the centre occupied by the ancestrula, which is usually surrounded by 7—8 zooecia of similar form and size, much smaller than their successors. Zooecia quincuncial, in longitudinal rows, and so arranged as to form oblique rows crossing the radial rows. Aperture occupying the entire surface, the operculum near the distal end, Membraniporine. Cryptocyst strongly developed all round the opesia, uniformly tuberculate, descending steeply and in parts almost vertically, to the opesia, which is rounded oval, slightly trifoliate or quadrangular. A vibraculum at the distal end of each zooecium, even of the ancestrula, its aperture on one side concave, and on the other provided with a strongly projecting tooth, incompletely calcified at its free end, serving for the articulation of the base of the seta. These teeth generally face the same way for some distance along an oblique row, the direction being then reversed. Seta (fig. 7) strong, stout and long at the periphery of the colony, much thinner and shorter in the central vibracula, the tip incurved and fine. In the central part the zooecia become occluded by a thin, horizontal lamina closing the opesia, and with a few, irregularly arranged pores.

Fig. 9. — *Cupuladria guineensis*. Zoarium (488. A 2), natural size.

The occluded zooecia just mentioned are not provided with polypides; and it appears that the zooecia become closed progressively from the centre, leaving the nutrition of the colony entirely to those of the marginal zone. The serration of the margin is due to the projection of certain rows, nearly always alternate ones, each of which is terminated by a rounded vibraculum, without showing any trace of further growth; nor do the intermediate rows give any indication of an increase in length. Growth thus seems to occur at intervals, separated by pauses, and the constancy of the presence of a serrated edge may be taken to imply that the alternate rows between the projecting vibracula would subsequently elongate, each forming a new zooecium, terminated by a vibraculum, on the completion of which growth presumably stops again for a time.

There is no trace of ovicells, which probably do not occur in this genus. Waters (1921, JLS, XXXIV, pp. 404, 411) describes ova and large embryos in some of the peripheral zooecia, in one of which he figures a large egg (in *C. canariensis*, Pl. XXX, fig. 25). I have found testicular tissue in some of the zooecia of a decalcified specimen of *C. guineensis*.

The species has been regarded by Waters (*t. cit.*, p. 411) and others as identical with *C. canariensis* Busk, described from Madeira and the Canary Is.; and if this were the case *C. canariensis* should be considered a synonym of *C. guineensis* of an earlier date. From a comparison of Madeiran specimens (Cambridge Coll.) of *C. canariensis* with the Siboga material I think that the two species are distinct. *C. canariensis* differs from *C. guineensis* in having relatively longer and narrower zooecia, in the narrower cryptocyst and in having larger pores on the basal surface.

Division 3. Coelostega.

Coilostega (pars) Levinsen, 1902, VMNFK, p. 2; — 1909, MSSB, pp. 89, 90, 161.

Fam. 1. Steganoporellidae.

Steganoporellidae Hincks, 1884, AMNH, 5, XIII, p. 358.
Steganoporellidae (pars) Hincks, 1887, AMNH, 5, XIX, pp. 162, 164.
Steganoporellidae Levinsen, 1909, MSSB, p. 167.
Steganoporellidae Canu and Bassler, 1920, USNMB, 106, p. 259.

This Family, characterised by the dithalamic condition of the zooecia, by its large opercula and mandibles and by the remarkably primitive vicarious avicularia, was introduced by Hincks in 1884, the only species mentioned being *Steganoporella magnilabris*. In 1887 he gave a more detailed diagnosis, but in addition to the type-genus he included *Smittipora* and *Thalamoporella*, which are now placed in distinct Families. Levinsen gave an amended diagnosis in 1909, restricting the Family to *Steganoporella* and *Siphonoporella*. The latter shows no dimorphism of the zooecia, and I do not think that it should remain in this Family.

1. **Steganoporella** Smitt.

Steginoporella Smitt, 1873, KVAH, XI, 4, p. 15.
Steganoporella Harmer, 1900, QJMS, XLIII, p. 225.
Steganoporella Levinsen, 1909, pp. 167, 168.
Steganoporella Canu and Bassler, 1920, p. 259.
Genotype, selected by Jullien, 1888, CH, p. 79, *Steginoporella elegans* Smitt (nec *Eschara elegans* Milne-Edwards, 1836, ASNZ, 2, VI, p. 337) [1]).

There can be no doubt that, according to the strict Rules of Nomenclature, the proper name of this genus is *Steginoporella*, introduced by Smitt as a diminutive of *Steginopora* D'Orbigny (1853, PFTC, p. 499). The form *Steganoporella* has been universally adopted by later authors, on etymological grounds, and I think that the emendation is justifiable.

Zooecia dithalamic, the body-cavity subdivided by an incomplete, descending lamina of the cryptocyst, which joins the basal or distal wall, leaving a median fenestra, prolonged distally into a more or less complete "polypide tube", which is traversed by the tentacles. In most of the species, parts of the frontal wall of the tube are prolonged into flanges forming the "median process", which usually has a frontal depression, its floor being formed by the roof of the tube. Gymnocyst wanting, the whole of the proximal region covered by the horizontal part of the porous cryptocyst and by its thickened margin, the "postoral shelf", on its proximal and lateral sides. Avicularia typically represented by enlarged zooecia, provided with a polypide, but distinguished from the other zooecia by differences in their distal portion and by possessing a mandible structurally different from the opercula. In *S. mandibulata* the avicularia have no polypide, and the mandible is linear distally and typically avicularian; while in certain other

1) Hincks (1887, AMNH, 5, XIX, p. 164) had previously given *S. magnilabris* Busk as the genotype, and this comes to the same thing as Jullien's selection of the following year, on the two assumptions (1) that *S. elegans* Smitt is not identical with *S. elegans* (M. Edw.); (2) that Smitt was right in regarding *Membranipora magnilabris* Busk (1854, BMC, p. 62) as synonymous with his own species. Smitt would no doubt have used Busk's name if he had not considered it a synonym of Milne-Edwards' species. *Flustra rozieri* Aud., the only other species included by him in *Steginoporella*, is the genotype of *Thalamoporella* Hincks (*l. c.*).

species avicularia have not been described. Zooecia and avicularia completely covered by the frontal membrane, the opercula and mandibles specially large, articulating with the calcareous frame and strengthened by chitinous thickenings (sclerites). Mandibles provided with a series of submarginal teeth, which may also occur on the opercula. Ovicells wanting. The embryo develops in an ovisac situated in the distal chamber of the body-cavity and underlying the operculum; probably restricted to the ordinary zooecia.

The genus *Steganoporella* is of particular interest, as it belongs to an evolutionary stage in which the avicularian individuals usually possess a polypide, and are accordingly as important as the ordinary zooecia in providing for the nutrition of the colony. It appears to be derivable from Membraniporine ancestors like *Acanthodesia*, in which the median process is foreshadowed and the avicularia, if present, are vicarious. In *S. mandibulata* n. sp., typical avicularia are present, and their polypide has disappeared. Similar structures have previously been described in species which have been referred to *Steganoporella*, as in *S. patula* by MacGillivray (1895, TRSV, IV, p. 54) and in *S. cavatura* by Canu (1916, BSGF, 4, XV, p. 323); both Tertiary fossils. I think that these species have been incorrectly placed in *Steganoporella*, and that they thus have no bearing on the question under discussion.

With the exception of those in which avicularia have not been described, the known species can be grouped in two series. In the first of these (Group I), which appears to represent an earlier stage in evolution, the avicularia are comparatively little differentiated; and they are often present in such small numbers as to suggest that they belong to the category of vestigial or disappearing organs. The mandibles of these avicularia are not unlike the opercula, from which they differ in their greater strength, in the presence of teeth, which are either absent or differently developed in the opercula, and in the greater development of their occlusor muscles. Owing to the arrangement of the principal sclerites, I have previously distinguished this group as possessing a ∩-shaped main sclerite (QJMS, XLIII, pp. 235, 242). In Group II, the mandible has a ∧-shaped main sclerite (*Ibid.*, p. 266), is broad distally and is provided with a series of submarginal teeth. The avicularia in both groups possess polypides. In Group III, now introduced, the mandible is linear distally and the modified individual has become a typical avicularium, without polypide.

The Geographical Distribution of the recent species [1]) is of much interest, in connexion with the present Report, since the Indo-Australian Region includes a larger number of species than have been described in any other district. In the majority of cases the specimens have been obtained from shallow water, though Ortmann (1889, ANG, LVI, 1, p. 30) described *S. magnilabris* as occurring, off Japan, in water as deep as 200 fath.; while one of the Siboga records of the same species is from 350 M. *Steganoporella* is found, as a rule, in warm water, though species are known from the southern ends of Africa, Australia and New Zealand. *S. magnilabris* has a wider distribution than any other species, being recorded from the Pacific, Indian and Atlantic Oceans, and being thus circumtropical, although reaching Japan, Florida and Bermuda, outside the Tropics. The area investigated by the Siboga is characterised by the prevalence of Group II, with 5 species; while the only known representative of Group III is from the same region.

1) Most of these are discussed in my 1900 paper cited above.

Only one species (*S. lateralis* MacGill.) of Group I has been found in the Siboga area, but *S. porteri* (Maplestone, 1909, PRSV, N.S., XXI, p. 412), which appears to belong to this Group, has been found in the Solomon Is. In the Indian Ocean, from which records are scanty, there does not seem to be the same disproportion between Groups I and II, as this area includes 2 species of Group II (*S. magnilabris* Busk and *S. buskii* Harm.) and the same number of Group I (*S. sulcata* Harm. and *S. simplex* Harm.), besides *S. auriculata* Harm., which may belong to the same Group. In the Atlantic the records are confined to the western side, with the exception of two species referred to, but not described, by JULLIEN (1888, CH, p. 79) as having been dredged by himself on the coast of Liberia.

The Geological history of *Steganoporella* is difficult to unravel, as many of the species thus recorded appear to have no claim to be placed in the genus. This applies to descriptions of KOSCHINSKY (1885, PAL, XXXII, 1, pp. 32—34) and HENNIG (1892, LUA, XXVIII, 11, pp. 34—36). On the other hand, *S. parvicella*, a Lower Miocene fossil from the West Indies, described by CANU and BASSLER (1919, CIW, 291, p. 89) is probably a *Steganoporella*; while Tertiary species have been recorded from Victoria by MACGILLIVRAY (1895, TRSV, IV, p. 53) and MAPLESTONE (1911, PRSV, N.S., XXIII, pp. 276—278). *Eschara elegans* Milne Edwards (1836, ASNZ, 2, VI, p. 337) is probably a *Steganoporella*, and CANU's statements (1916, BSGF, 4, XV, p. 323; 1917, 4, XVII, p. 355) on the subject may be consulted with advantage. If this is the case, *Steganoporella* is known as a Tertiary fossil from South-west France, and perhaps even from the Miocene of Austria-Hungary (KOSCHINSKY, 1885, p. 34). I am not convinced that all the species referred to this genus by CANU and BASSLER (1920, USNMB, 106, pp. 262—265) really belong to it. *S. vicksburgica* (p. 264), from the Oligocene, seems to be correctly placed, but the other 3 species are perhaps referable to the Labioporellidae.

ANATOMY (Pl. XVII).

(a) Reproductive organs and dimorphism.

The study of the reproductive organs is of interest in relation to the dimorphism of zooecia which is so characteristic of *Steganoporella*. In my Revision of the genus (1900) I distinguished the two forms as, respectively, the "A" and "B" zooecia; suggesting (p. 236) that the "B" zooecia are probably to be regarded as avicularia, in spite of the fact that, like the "A" zooecia, they are provided with a polypide. BUSK (1884, Chall., p. 75) had been inclined to regard them as ooecial in nature; while CANU (1907, AP, II, p. 141), in discussing his genus *Gaudryanella*, implies that, in his opinion, the larger "B" zooecia are probably "zoécies ovariennes". WATERS (1913, BEA, pp. 499, 500), who has given an account of the anatomy of *Steganoporella*, states that "the embryos develop at the base of the distal chamber"; but he does not appear to distinguish between "A" and "B" zooecia in this respect. MARCUS (1922, AI, p. 428, Pl. XXIV, fig. 5*a*) also states that the fully developed embryo fills the distal chamber. He does not explain whether he found it, or the ovary, in both kinds of zooecia, but his figure, showing an ovary, is given, in the explanation of the Plate, as that of a "B" zooecium. The details of the mandible, however, are not typical of the species represented.

I can confirm the statements of WATERS and MARCUS, in general; but with this difference,

that, according to my observations, in *S. magnilabris* (Pl. XVII, fig. 9), *S. dilatata* and *S. lateralis*, ovisacs containing eggs or embryos are restricted to the "A" zooecia. In the light of this evidence it is impossible to regard the "B" zooecia as "ooecial". The fact that they do not appear (unless MARCUS is right) to produce eggs suggests that they have proceeded far enough along the road of differentiation as avicularia to have lost this power, which the „A" zooecia retain.

The view that the "B" zooecia are morphologically avicularia — and I here describe them under this name — is strongly supported by *S. mandibulata* n. sp. This interesting form has ordinary ("A") zooecia which are typical in the characters of their cryptocyst, median process and tube; while their large, toothed opercula are comparable with the "A" opercula of other species. The "B" zooecia are definitive avicularia, with a typical, acute mandible. This is derivable from the form provided with a Λ-shaped main sclerite, such as that of *S. haddoni* (HARMER, 1900, Pl. XIII, fig. 38), by the disappearance of the lateral portions situated externally to the main sclerite. The avicularium of *S. mandibulata* possesses no polypide, which, in other species, is equally developed in both kinds of zooecia. As a further argument in favour of the avicularian nature of the "B" zooecia, may be mentioned the fact that the occlusor muscles of their mandibles are definitely differentiated from those of the opercula of the "A" zooecia.

Fig. 9 (Pl. XVII) represents a zooecium of *S. magnilabris* which is shown by its operculum to belong to the "A" type. A large egg or embryo lies beneath the operculum, in the distal division of the body-cavity, and is contained in a spacious, thin-walled ovisac (*ov.*), which fills most of the distal chamber, extending nearly to its basal wall. By the study of this and other preparations it can be seen that the ovisac is attached to the lateral walls of the zooecium by a number of muscle-fibres, and that the tentacle-sheath of the polypide runs over the frontal wall of the ovisac, where it meets the diaphragm separating it from the subopercular vestibule. I have not ascertained whether the ovisac opens into the vestibule, but in other respects it is completely comparable with that described by CALVET (1900, TIZM, N. S., 8, p. 265, text-fig. 42) in "*Lepralia*" *pallasiana*. According to this author (see also p. 413), the ovisac is a diverticulum of the vestibule, into which it permanently opens.

The male elements in *S. magnilabris* occur as a number of isolated, rosette-like masses of sperm-cells; and in one of the specimens from Japan I have clearly seen the tails of the spermatozoa radiating from these masses into the body-cavity. Sperm-cells of this type occur in the neighbourhood of the basal wall of the distal division of the body-cavity; and I have also found them on the frontal wall of the alimentary canal, in the proximal division. In respect of the male cells the avicularia are less differentiated than as regards the ova; since I have found sperm-rosettes in both kinds of zooecia. A parietal ovary has been distinguished on one of the lateral walls, in the ordinary zooecia only. In 345. A (*S. magnilabris*) I have found both eggs and spermatozoa; but in the Japanese material I have observed spermatozoa, but not eggs.

(b) Opercula, mandibles and the associated muscles. Rosette-plates.

The large size of the chitinous parts in *Steganoporella* renders this genus a particularly favourable one for investigation. I have already described these parts in previous papers (1900, QJMS, XLIII, Pl. XIII; 1902, QJMS, XLVI, p. 317). The following notes may be added.

In a longitudinal section of *S. magnilabris* (fig. 3), prepared as a thick slice, without

decalcification, the closed mandible is seen to overlie a cavity, the vestibule (*v.*). When the mandible is thrown back, through an angle of 180°, its basal wall is in line with the floor of the vestibule, the cavity of which has disappeared. Near its proximal end the vestibule opens by a narrow passage, formed by the diaphragm (*d.*), a valvular structure with thickened walls, into the cavity of the tentacle-sheath (*t. s.*). The mandible consists, near its middle line, of two distinct layers of chitin; the superficial layer being continuous with the frontal membrane, of which it is a differentiated, more highly chitinised portion. The deeper layer, which gives rise to the principal sclerites, is formed by the roof of the vestibule. The two layers diverge from one another proximally, so that at the base of the mandible the cavity between them is of some vertical depth and it here opens into the body-cavity. The main sclerite (*m. s.*) and the toothed edge belong to the deeper layer. In a frontal or basal view of the entire mandible (HARMER, 1900, Pl. XIII, fig. 44), the two halves of the main sclerite are seen to approach one another in the distal half, the cavity between them being here narrow; while still more distally it widens in a T-like manner. Fig. 3 shows this distally widened part, separated from the more proximal part of the cavity by one of the halves of the main sclerite (*m. s.*); the section not being completely median.

Reference may be made, at this point, to the description I give below of the completely bilaminar opercula of the Aspidostomatidae, in which, however, the deep layer is uniformly chitinised and does not possess the complicated arrangement of sclerites which is so characteristic of *Steganoporella*. The opercula and mandibles of the Cheilostomata in general are probably of this bilaminar construction, although the two layers may be so closely apposed as not to be readily distinguishable.

The muscles of *S. magnilabris* occupy the outer parts of the distal chamber of the body-cavity, and they do not fill it so completely as in *S. alveolata*, of which I have previously given a description (1902, p. 317). The mandible is closed, as in some typical avicularia (see JULLIEN, 1888, CH, Pl. XII, fig. 3), by two pairs of large muscles. Of these, the distal occlusors (figs 2, 3, *occ.*[1]) originate partly from the distal wall and partly from the distal part of the basal wall, the narrow tendons passing into a transverse fascia (*f.*) (as described in my earlier paper, 1902, Pl. XVIII, fig. 64, f.[1]), inserted into the proximal projecting ends of the main sclerite; and also, as shown by fig. 3, into the proximal end of the wall of the vestibule, in the more median part of the mandible. The proximal occlusors (fig. 3, *occ.*[2]) are in contact with the distal occlusors, originating from the basal wall, just on their proximal side. Their tendons pass into the occlusor-tubercles on the halves of the main sclerite. The divaricators (*div.*) are inserted into the frontal membrane, close to the base of the mandible. A pull on this membrane is no doubt as effective in opening the mandible as if the muscle were inserted directly into that structure. The depressors (*dep.*) originate, with the divaricators, from the basal wall, in the immediate neighbourhood of the proximal occlusors; and they are inserted into the depressor sclerites[1]) (fig. 8, *d. s.*) of the frontal membrane.

The divaricator and depressor muscles are probably differentiations of the system of parietal muscles, which in many Cheilostomes are inserted in groups into the frontal membrane,

1) I use this term in preference to "epithecal sclerites" of my earlier paper (1900).

along the greater part of its length, on each side. In many Cheilostomes the two pairs of muscles do not seem to be differentiated; and a single pair perform the double function of opening the operculum and of depressing the frontal membrane, so as to cause the fluid pressure by which the polypide is protruded. The two pairs of occlusor muscles are probably two differentiated parts of one original pair of occlusor muscles. This conclusion is supported by the study of the ordinary zooecia (fig. 7), in which I find depressor (*dep.*) and divaricator (*div.*) muscles, as in the avicularia, but only a single pair of occlusors (*occ.*), originating from the basal wall.

Fig. 12, a basal view of an ordinary zooecium, shows that the opening and closing of the operculum is further regulated by other muscles and ligaments. Four bands (*l. b.*), which appear to be ligamentous, run from the tentacle-sheath to the distal wall (cf. WATERS, 1913, BEA, Pl. LXXII, fig. 19). In a side view (see zooecium 2 in fig. 1), they are seen to lie in line with the retracted polypide, which they doubtless prevent from being pulled too far back by the contraction of its retractor muscles; these originating, as usual, from the proximal end of the zooecium. A lateral pair of parieto-vaginal muscles (fig. 12, *p. v.*) is inserted into the distal part of the tentacle-sheath; and, just distally to them, a similar pair of parieto-vestibular muscles (*p. vest.*) pass to the vestibule. The contraction of these two pairs must tighten the floor of the vestibule and thus help to keep the operculum in place during its closed period. There is finally a pair of ligaments (*l. b.*[1]), originating from the lateral recesses and inserted into the tentacle-sheath.

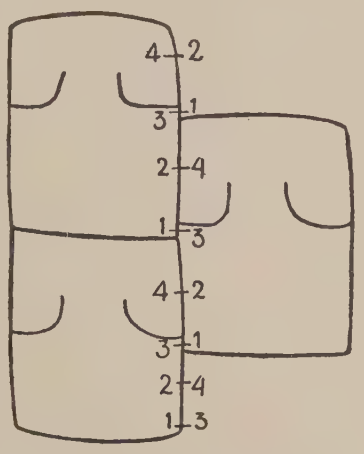

Fig. 10. — *Steganoporella magnilabris.* Diagram to show the arrangement of the rosette-plates.

Fig. 1 shows the relation of the polypide to the calcareous tube. The specimen is from Japan, and the tube is much more extensively developed, on its proximal side, than in the Siboga material. Four multiporous, lateral rosette-plates (*r. p.* 1, 4) are seen in each zooecium. Numbering these from the proximal end, 1—3 open into the proximal division of the body-cavity, N° 3 close to the base of the tube; while N° 4 communicates with the distal division. As shown by text-fig. 10, the correspondence between these plates and those of the adjoining zooecia may be thus expressed: — 1,3; 2,4; 3,1; 4,2. The distal rosette-plates are usually two in number.

Key to the Indo-Australian species of *Steganoporella.*

1	Mandibles with ∩-shaped main sclerite. Tuble simple, horned distally, but without lateral wings.	1.	*S. lateralis.*
	Mandibles with Λ- or ⅄-shaped main sclerite		2.
2	Mandibles linear distally, typically avicularian	7.	*S. mandibulata.*
	Mandibles broad distally		3.
3	Opercula with straight or slightly concave distal border, each tooth of mandibles fitting into a pit in the calcareous oral shelf. . .	6.	*S. alveolata.*
	Opercula rounded distally, more or less semicircular		4.

4	Mandibles greatly widened distally	2.	*S. dilatata.*
	Mandibles not greatly widened distally		5.
5	Cryptocyst joining the basal wall at some distance from its distal end. Opercula with a basal sclerite and numerous small submarginal teeth.	3.	*S. magnilabris.*
	Cryptocyst joining the distal wall. Opercula without complete basal sclerite, toothless		6.
6	Mandibular teeth long, fine, restricted to distal half of mandible. Avicularia about twice as large as zooecia	5.	*S. haddoni.*
	Mandibular teeth small, commencing in the proximal half of mandible. Avicularia not twice as large as zooecia	4.	*S. buskii.*

The following records of species belonging to Group I, from just outside the Siboga area, may also be noticed: —

S. sulcata Harm.

Steganoporella sulcata Harmer, 1900, p. 246. Mergui, Ceylon, Amirante Is.
Steganoporella sulcata Thornely, 1905, PGM, p. 112. Ceylon; — 1907, MPIM, p. 186. Andaman Is.

S. simplex Harm.

Steganoporella simplex Harmer, 1900, p. 253. Amirante Is.
Steganoporella simplex Thornely, 1905, p. 112. Ceylon; — 1907, p. 186.

S. porteri Mapl.

Steganoporella porteri Maplestone, 1909, PRSV, N. S., XXI, p. 412. Solomon Is.

Group I. Mandibles with ∩-shaped main sclerite.

1. *Steganoporella lateralis* MacGill. (Pl. XVII, figs 5, 6, 8, 13).

Steganoporella lateralis MacGillivray, 1895, TRSV, IV, p. 53, Pl. VI, fig. 18. Tertiary, Victoria.
Steganoporella lateralis Harmer, 1900, QJMS, XLIII, p. 242, Pl. XII, fig. 1; Pl. XIII, figs 19, 20, 27. Torres Straits, Tahiti.
Steganoporella lateralis Levinsen, 1909, MSSB, p. 168, Pl. V, figs *7a—d.*

325. A. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
487. A. Stat. 129. Karkaralong Group, S. of Mindanao, 0—31 M.
394. C. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M.
528. A. Stat. 220. Binongka Id, S. E. of Celebes, 55 M.
279. C. Stat. 250. Kur Id, Kei Is, 0—45 M.

Cambridge, Mus. Zool.: —

Torres Straits, 184. A. C. HADDON, Reg. Feb. 24, 1898.

For diagnosis see my "Revision" (1900), p. 242; which must, however, be amended by stating that the mandibles may or may not have a basal sclerite. *S. lateralis* is generally found encrusting other objects, but 528. A was partly encrusting, partly erect and unilaminar.

This species is the only one known to me in which the tube is quite simple in structure, without lateral wings or a depression on its frontal wall. The cryptocyst joins the basal wall, and the mandibles may be exceptional in possessing no basal sclerite (fig. 8). 394. C and 487. A are provided, however, with this structure (fig. 13), which is probably represented, both in the opercula and in the mandibles, by the sclerites which I formerly described (p. 245, Pl. XIII, fig. 20, *f.*) as the "buttresses" on the inner side of the proximal ends of the main sclerite. The

figures on the Plate cited show that these buttresses are present only in opercula not possessing a complete basal sclerite. It is thus natural to regard them as the ends of a basal sclerite, the middle portion of which is not developed.

The avicularia of *S. lateralis*, as distinct from their mandibles, have not previously been described, although I think that the larger individual shown by LEVINSEN (fig. 7*b*) is of this nature. Fig. 13 represents one of them in a stained Canada balsam preparation. The mandibles in this colony (487. A, two individuals) are provided with a complete basal sclerite. The oral arch and the condyles are larger than in the zooecia. The frontal lip of the tube, with its two horns, is reflected, in the figured specimen, towards the proximal end of the zooecium, and it overlies part of the frontal wall of the tube; but this arrangement does not occur in the Torres Straits specimens and in most of the zooecia of 279. C, in which however they occur as minute vestiges in two zooecia. The depressor sclerites (*d. s.*) are seen in fig. 13. In a basal view of the same avicularium (fig. 5) the tube is shown to be asymmetrical in its origin. The cryptocyst joins the basal wall at some distance from the distal wall; and the distal body-cavity, which contains an enormous mass of muscles (*occ.*), is large, in comparison with that of the zooecia.

In another specimen (279. C) three avicularia were identified by the character of their mandibles, and their position was recorded in sketches. The mandibles, one of which is shown in fig. 8, were then removed and mounted, and the pieces of the colony were also mounted as a cleaned, dry preparation. Unless the position of these avicularia had been carefully recorded it would have been difficult, if not impossible, to be certain how many of these individuals without chitinous parts were avicularia, in frontal view at least. In their zooecial characters the zooecia and the avicularia are in fact not very distinct from one another.

The mandibles of the Siboga specimens are in general like the one previously figured by me (1900, fig. 20), but are somewhat shorter, as shown by figs 8 [1]) and 13. The teeth, of which 8, 10 and 11 were counted, with indications of vestigial teeth outside the large ones, are specially strong; and the occlusor-tubercles (*occ. t.*) are also large. The avicularium possesses a polypide.

The tube is markedly asymmetrical in the ordinary zooecia, and in my former paper (p. 244) I suggested that this was probably correlated with the position of the polypide. This is shown to have been correct by fig. 6, which represents two zooecia in basal view. In one case the tube springs from the right side of the zooecium, and the tentacles are on the same side, the stomach lying to their left. In the other zooecium these relations are reversed.

In 325. A, in which no avicularia were found, eggs were present in the ordinary zooecia, confirming the results obtained in *S. magnilabris* and *S. dilatata*.

Group II. Mandibles with a Λ-shaped main sclerite; broad distally.

2. *Steganoporella dilatata* n. sp. (Pl. XVII, figs 10, 11; Pl. XVI, fig. 19).

Type. 413. A. Stat. 315. Paternoster Is, N. of Sumbawa, 0—36 M. Encrusting a piece of calcareous rock.
251. G. Same Station, on a small Gasteropod shell.

Encrusting. Zooecia short, the descending cryptocyst inserted near the junction of the

1) The mandible is somewhat foreshortened, its real length being greater than as shown in the drawing.

basal and distal walls, not angulated at its commencement. Median process well developed, with deep frontal cavity limited by upstanding walls. Tube complete basally, separated from the insertion of the cryptocyst by a considerable interval. Oral shelf moderate, condyles very prominent and recurved. Avicularia much longer than the zooecia, the oral shelf greatly developed and the oral arch widened distally, its distal margin nearly straight. Descending cryptocyst vertical, joining the basal wall at a great distance from the distal wall. Opercula undifferentiated, the tubercles for the insertion of the occlusor muscles prominent. Mandibles greatly widened distally, the whole of the distal and lateral margins bearing a series of numerous, rather weak teeth. The two halves of the main sclerite not confluent distally, not reaching the end of the mandible. Depressor sclerites present in both the zooecia and the avicularia.

This very well marked species differs from all other members of Group II with which I am acquainted by the fact that the main sclerite forms a simple Λ, which terminates at some distance from the distal margin of the mandible. In other species the two halves of the sclerite approach one another distally, forming a narrower portion which expands at its end, where it joins the submarginal sclerite. The absence of the distal part of the main sclerite, together with the remarkable broadened end of the mandible and the corresponding form of the avicularium itself, as well as the greatly developed oral shelf of the avicularium, are striking characters. In the possession of opercula of the „undifferentiated" type (*i. e.*, with neither basal sclerite nor teeth), *S. dilatata* resembles *S. buskii* and *S. haddoni*, to which it may be considered allied. The hook-like condyles of the zooecia extend into the cavities on the outer sides of the proximal ends of the main sclerite of the operculum.

The postoral shelf of both zooecia and avicularia (Pl. XVI, fig. 19) is thick and strongly tuberculated. In neither kind of individuals is the cryptocyst angulated at the commencement of its descending portion, except at its sides, where the edges of the median process join the postoral shelf. While the descending cryptocyst, in the avicularia, is inserted into the basal wall, far from its distal termination, the corresponding part of the zooecia is variable in its insertion. In these individuals this part of the cryptocyst may be transverse or oblique, involving corresponding variations in the direction of the opening of the tube. It may thus join the basal wall, near its junction with the distal wall, or the basal part of the distal wall, or may be inserted partly into the basal and partly into the distal wall, its line of insertion being usually asymmetrical. In a basal view of the colony the insertion of the cryptocyst may thus extend, as a curved line, across the entire width of the basal wall, near its distal end, or may merely cut off one corner of the basal wall, extending from a point near the distal end of the junction between basal and lateral walls of one side to the middle of the junction of the basal and distal walls; thence passing entirely along the distal wall and being here invisible in basal view.

The tube is not much more than a round fenestra in the descending cryptocyst, but its frontal wall is usually slightly developed, so that the structure is actually a half tube, its wall dying away basally. The floor of the median process, or in other words the frontal side of the roof of the tube, commonly bears small granulations or tubercles.

The proximal part of the oral shelf of the avicularia is strongly thickened and tubercular, its distal part being thin and constituted by an unaltered part of the distal wall separating the avicularium from the next member in the series.

The depressor sclerites (Pl. XVII, figs 10, 11, *d. s.*) are distinct in both kinds of individuals, and have a curved form, with the concavity on the median side. They are more strongly curved in the avicularia than in the zooecia.

I have not observed spermatozoa in this species, but a certain number of the ordinary zooecia contain eggs or embryos. Each egg lies in a thin-walled ovisac, beneath the operculum, and entirely in the distal chamber of the body-cavity. Polypides and several brown bodies occur in both kinds of individuals. The number of tentacles appears to be not less than 20.

The rosette-plates, as observed in the zooecia, are multiporous. Those of the distal wall are situated just on the frontal side of the insertion of the cryptocyst, and they vary in number. A single pair are commonly observed, but there may be one or even two smaller ones, on one or both sides, in addition. The lateral rosette-plates are at least three in number, and four are probably present.

3. *Steganoporella magnilabris* (Busk). (Pl. XVII, figs 1, 2, 3, 7, 9, 12, text-fig. 10, p. 273).

Membranipora grandis Busk, 1852, BMC, p. VI (Descr. of Plates), Pl. LXV, fig. 4.
Membranipora magnilabris Busk (pars), 1854, pp. 62, 113. Abrolhos Is (Brazil).
Steginoporella elegans Smitt, 1873, KVAH, XI, N^0 4, p. 15, Pl. IV, figs 96—101. Florida, 15—37 fath.
Steganoporella elegans Verrill, 1900, Trans. Connect. Acad., X, p. 594. Bermuda.
Biflustra crassa Haswell, 1880, PLSNSW, V, p. 38, Pl. I, fig. 8. Queensland.
Steganoporella magnilabris Harmer, 1900, QJMS, XLIII, p. 279, Pl. XII, fig. 10; Pl. XIII, figs 31, 44—46.
Steganoporella magnilabris Levinsen, 1909, MSSB, p. 168, Pl. V, figs 5*a—c*.
Steganoporella magnilabris (sp. ?), Thornely, 1912, PIOS, p. 145. Amirante Is.
Steganoporella magnilabris Waters, 1913, BEA, p. 498, Pl. LXXII, figs 12—20. British E. Africa, Zanzibar, Trincomali.
Steganoporella magnilabris Osburn, 1914, CIW, 182, p. 196. Tortugas Is (Florida).
Steganoporella magnilabris (sp. ?), Robertson, 1921, BBB, p. 52. Bay of Bengal, Andamans, Ceylon, Burma.
Steganoporella magnilabris Okada, 1923, AZJ, X, p. 224. Corea.
Steganoporella magnilabris Canu and Bassler, 1923, USNMB, 125, p. 63, Pl. XIV, figs 12, 13. Miocene and Pliocene, N. America.

433. F. Stat. 7. Batjulmati, Java, 15 M. and more (unilaminar, dead).
10. A. Stat. 33. Pidjot Bay, Lombok, 0—22 M. (unilaminar).
388. A. Stat. 81. Borneo Bank, Strait of Makassar, 0—34 M. (encrusting).
60. A. Stat. 98. Sulu Archipelago, 350 M. (unilaminar, dead).
74. A. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M. (bilaminar, dead).
97. A. Stat. 123. Biaru Bay, N. E. of Celebes, 27—36 M. (unilaminar).
345. A. Stat. 213. Saleyer, S. of Celebes, 0—36 M. (unilaminar).

Cambridge, Mus. Zool.: —

Singapore, 12 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.
BM Japan, 43. A, off Tokyo, 53—55 fath., A. OWSTON, Reg. June 23, 1902.

For diagnosis, see my Revision, 1900, p. 279. In one or two of the unilaminar pieces the basal surface bears large tubercles, indicating attachment to another object.

I have given a synonymy of this species, as restricted by me, in my Revision of the genus (1900), and it is unnecessary to repeat all these references. I have there shown that many

of the specimens previously recorded under this name were incorrectly determined. I previously expressed some doubt with regard to the determination of *Biflustra crassa* Haswell, but I have more recently been able to examine specimens from HASWELL's own collection (Brit. Mus., 10. 6. 16. 3. and Cambridge Mus., Reg. July 31, 1900), and I believe them to belong to BUSK's species, principally on the evidence of the situation of the descending cryptocyst.

S. magnilabris Waters (1882, QJGS, XXXVIII, p. 506, Pl. XXII, figs 7, 7*a*), an Australian Tertiary fossil, may be definitely excluded from this species on the evidence of the direction of the tube, which opens frontally, instead of distally. I have thus no reason for regarding WATERS' later record (1885, QJGS, XLI, p. 292) of this species as an Australian fossil as correct.

The trivial name *grandis* appears in the explanation of BUSK's Plate LXV, which was published two years before his description, in which he altered the name to *magnilabris*. I have not thought it necessary to substitute *grandis* for the familiar and generally accepted designation.

As shown in my earlier paper, this species has a very wide distribution, as it has been recorded from Brazil, Florida and the West Indies, as well as from Singapore, the Philippine Is, the China Sea, Japan and Queensland. To these localities may now be added, if the respective determinations are correct, British E. Africa, Zanzibar and Trincomali (WATERS) and Bermuda (VERRILL).

The mandibles of *S. magnilabris* are commonly provided with minute lateral teeth and longer distal teeth. The opercula have very distinctive features in possessing a number of minute marginal teeth and a basal sclerite. As I previously pointed out (p. 282), this is the only species of Group II in which the cryptocyst of both zooecia and avicularia joins the basal wall at a considerable distance from the distal wall. In correlation with the sharp descent of the cryptocyst, the opening of the tube lies in a transversely vertical plane, and is invisible in frontal view.

The Siboga specimens may be described as typical representatives of the species. The mandibles have, however, a more regularly curved margin than in the specimen I have previously figured (Pl. XIII, fig. 44). They vary considerably in their absolute size and in the ratio, length to breadth. Some are very short, and even wider than long. The small proximal teeth of the mandibles may be absent, but occur in other mandibles from the same colony.

I previously (p. 236) called attention to the variation in the relative numbers of zooecia and avicularia, in different species of *Steganoporella*, or in different specimens of the same species. In describing specimens from British E. Africa, WATERS (1913, p. 498) has remarked on the rarity of avicularia, which were completely absent in two pieces, each consisting of about 300 individuals. In 345. A I have found the opposite condition, only 8 zooecia being present, accompanied by 21 avicularia. In another fragment of the same colony the numbers were about equal; — 22 zooecia and 26 avicularia.

The eggs (fig. 9) and male organs of this species have been described above (p. 271); with other anatomical details which are illustrated by figs 1—3, 7, 9, 12 (Pl. XVII) and by text-fig. 10 (p. 273).

In 345. A one or two specimens of a small *Loxosoma*, apparently with 8 tentacles, lie inside the vestibule, and are therefore covered by the closed mandible. I have been unable to decide whether they are to be referred to any of the species described by me in Part I of this Report.

Abnormalities. — The following cases, illustrating different forms of regeneration, may be noticed.

433. F. — The colony had been injured during life, and some of the zooecia had been regenerated. A zooecium bifurcates at its distal end, and two complete oral arches are present. These have been completely closed by a calcareous lamina, and a normal orifice has been developed at the original proximal end of the zooecium, facing in the opposite direction to that of the original oral arches.

345. A^3. — A mandible is torn at its distal margin, on one side of the middle line. A new margin has been developed on this side, inside the old one, and concentrically with it; and it bears normal teeth. Two sets of teeth are thus present on this side, and for a short distance beyond the median line of the distal margin.

The following species of Group II, though not included in the Siboga collection, are recorded from the Indo-Australian Archipelago.

4. *Steganoporella buskii* Harm.

Steganoporella buskii Harmer, 1900, QJMS, XLIII, p. 272, Pl. XII, fig. 13; Pl. XIII, figs 33—35. Talisse Id, N. Celebes; Torres Straits; Arabia; South Africa; Australia.
Steganoporella buskii Thornely, 1905, PGM, p. 112. Ceylon.
Steganoporella buski Levinsen, 1909, MSSB, p. 168, Pl. V, figs 6*a—c*.

5. *Steganoporella haddoni* Harm.

Steganoporella haddoni Harmer, 1900, p. 268, Pl. XII, fig. 11; Pl. XIII, figs 38, 39. Torres Straits; Australia.
Steganoporella haddoni Marcus, 1922, AI, p. 428, Pl. XXIV, figs 5*a, b*.
Steganoporella magnilabris MacGillivray, 1895, TRSV, IV, p. 53, Pl. VI, figs 14—16. Victoria, Tertiary.

6. *Steganoporella alveolata* Harm.

Steganoporella alveolata Harmer, 1900, p. 287, Pl. XII, fig. 12; Pl. XIII, figs 32, 40, 41. Torres Straits.
Steganoporella alveolata Harmer, 1902, QJMS, XLVI, p. 317, Pl. XVIII, figs 64—66.

Group III. Mandibles with ʌ-shaped main sclerite; linear distally.

7. *Steganoporella mandibulata* n. sp. (Pl. XVII, fig. 4; Pl. XVI, fig. 20).

394. A. Stat. 144. S. of Halmaheira (Djilolo), 45 M. One colony, encrusting a piece of calcareous rock.

Encrusting. Dimorphism accentuated by the transformation of the "*B*" zooecia into typical vicarious avicularia. Zooecia large, the oral arch nearly half as long as the frontal surface. Oral shelf undeveloped, condyles very prominent. Cryptocyst forming a broad, granulated, postoral shelf round the proximal and half the lateral sides of the zooecium; its porous portion transversely crescentic, limited distally by a transverse thickened band, from which the descending part passes, nearly at right angles, to join the basal wall. Median process small, variable, merely a triangular, flat lobe or with a frontal depression, bounded laterally and distally by an

upstanding edge. Tube opening obliquely distally, its wall very slightly developed, complete or incomplete [1]) distally, usually separated from the median process by a vertical calcareous lamina. Opercula (Pl. XVII, fig. 4) more or less semicircular, with an evenly curved distal margin, bearing 9—13 strong teeth, of which the proximal pair are distinctly larger than any of the others. Avicularia in series with the zooecia, but much smaller, hardly exceeding half their breadth. Oral arch narrow distally, wider proximally, where its sides are convex inwardly. Cryptocyst without porous or descending portions, represented only by the postoral shelf. Mandible not articulating with the calcareous part, its base slung in the frontal membrane; the proximal parts of the main sclerite strong, curved, uniting to form the narrow distal portion, which is compressed and knife-edged, ending in a slightly curved, acute tip.

The avicularium (Pl. XVI, fig. 20) of this species contains no functional polypide. Its opesia is nearly oval, but its distal portion is overhung, and therefore concealed in frontal view, by the two sides of the oral arch, which has a short floor, representing an oral shelf, at its extreme distal end. The occlusors fill most of the distal part of the body-cavity, in the avicularium, while the divaricators, shown in the right hand avicularium of fig. 20, are smaller and converge from the proximal side to the two ends of the base of the mandible. In the zooecia, I have distinguished two muscles; — a large occlusor (*occ.*), on each side, originating from the lateral wall, on the distal sides of the condyles; and another pair (*dep.*), originating from the descending cryptocyst, and passing, in the lateral recesses, to their insertion along a narrow line between the median process and the condyle, on each side, into the frontal membrane. These are no doubt the depressor muscles, but they probably serve to depress the frontal membrane, thus protruding the polypide, and at the same time, by their tension on the membrane, to open the operculum.

In a dry preparation I have observed a deficiency in the descending cryptocyst, between the tube and the basal wall, but on one side only. If this is of normal occurrence, it implies that there is a fenestra placing the proximal and the distal portions of the body-cavity in communication with one another, near the basal wall of the zooecium.

Fam. 2. Labioporellidae nov.

Zooecia dithalamic. Horizontal cryptocyst large, porous, giving rise to a median process distally, and with a descending portion joining the basal wall. Avicularia vicarious, without polypides. Opercula small and toothless, not articulating with the calcareous parts, which have no condyles (in the zooecia).

The Labioporellidae appear to be allied to the Steganoporellidae, with which they agree in the characters of the cryptocyst and tube and in the comparatively undifferentiated avicularia. They differ from them in the structure of the avicularia and in the small and simple opercula.

Labioporella is the only genus which I can place, at present, in this Family. *Siphonoporella* Hincks, which includes *S. nodosa* Hincks (1880, AMNH, 5, VI, p. 90), the genotype, and

1) As the basal walls of the zooecia were removed, this point cannot be decided with certainty.

S. delicatissima (Busk) (see HARMER, 1900, QJMS, XLIII, p. 232), has some resemblance to it but it differs in having a proximal gymnocyst, in the unilateral position of its tube and in the absence, so far as is known, of avicularian individuals. It may perhaps be necessary to establish a new Family for the reception of HINCKS' genus.

Labioporella nom. nov.

Labiopora Levinsen, 1909, MSSB, pp. 171, 174.
Labiopora Canu and Bassler, 1920, USNMB, 106, p. 258.

The genotype is *Labiopora crenulata* Levinsen, whose generic name cannot be accepted, as it is pre-occupied by *Labiopora* Moseley (1879, PTRS, CLXIX, Pt II, p. 476), a genus of Hydrocorallina. LEVINSEN placed his genus in the Aspidostomatidae, from which it appears to be excluded by the absence of a cryptocyst-ridge of the *Aspidostoma* type, by the occurrence of a descending cryptocyst, by the presence of a postoral shelf, by the characters of the large avicularia and by the small, simple, not bilaminar opercula. The presence of multiporous rosette-plates in *Labioporella* is also a point of difference, while there is no evidence of the occurrence of ovicells.

Zooecia in distinct, longitudinal rows, the edges well raised. Gymnocyst wanting. Cryptocyst with a descending lamina, joining the basal wall, giving off a complete or incomplete, submedian tube, on either side of which is a lateral recess. Horizontal cryptocyst porous, occupying the greater part of the frontal surface, with a narrow postoral shelf, extending beyond the sides of the orifice completely round its distal border. Walls of the lateral recesses joining the lateral walls of the zooecium. Large, vicarious avicularia present, their cavity partially divided by a septum rising from the basal wall. Ovicells probably wanting. Rosette-plates multiporous.

A species from the Lower Miocene of the West Indies has been described by CANU and BASSLER (1919, CIW, 291, p. 89) as *Labiopora miocenica.*

Key to the species of *Labioporella* here described.

1	Frontal lip of tube prolonged distally into two lateral laminae which join the basal and lateral walls. Lateral recesses reaching the basal wall.	4.	*L. cornuta.*
	Frontal lip of tube with no distal horns. Lateral recesses with a floor raised above the basal wall		2.
2	Avicularia comparatively narrow, sometimes asymmetrical, with deeply depressed rostral floor	5.	*L. thornelyae.*
	Avicularia broad, at least distally, symmetrical		3.
3	Opesia of avicularium hardly extending beyond the condyles. Main sclerite of mandible confined to the proximal half.	3.	*L. bursaria.*
	Opesia of avicularium extending well beyond the condyles. Main sclerite of mandible reaching the distal half		4.
4	Rostral floor of avicularium, in middle line, much shorter than the opesia. Mandibular teeth minute	2.	*L. spatulata.*
	Rostral floor not much shorter than the opesia. Mandible much widened distally, its teeth large.	1.	*L. crenulata.*

1. *Labioporella crenulata* (Lev.). (Pl. XXI, figs 1—3).

Labiopora crenulata Levinsen, 1909, MSSB, p. 174, Pl. VI, fig. 4*a*.

Cambridge, Mus. Zool.: —

BM Torres Straits, 104, A. C. Haddon, Reg. Feb. 24, 1898.
(sp.?) Torres Straits, 33, same Collection (without avicularia).

Encrusting, zooecia oblong. Tube often asymmetrical, the lateral recesses with a floor distinct from the basal wall. Distal cryptocyst strongly crenulate in the region of the opesia. Avicularia large, the proximal portion sometimes as long as the rostrum; their opesia large, oval or pear-shaped, extending beyond the condyles, the distal edge denticulate, at least in part. Rostral floor large, most depressed distally. Mandible spatulate, becoming narrower on the distal side of its base, then expanding; bearing large teeth distally; its main sclerite well developed and reaching the distal half.

The species of this genus are difficult to distinguish in the absence of avicularia, which appear to give good diagnostic characters when present. These individuals were insufficiently described by Levinsen, and the locality of his material was unknown. The following considerations seem, however, to justify the reference of the Torres Straits specimens to Levinsen's species. *L. spatulata* differs from his figure in the greater distal extension of the avicularian opesia and in the corresponding shortness of the rostral floor; while the mode of insertion of the descending cryptocyst of the zooecia into the basal wall differs from his account. *L. bursaria* may be excluded by the form of its mandible, which does not agree with Levinsen's figure. Levinsen calls attention to the facts that the avicularian opesia is denticulate and that its rostral floor is most depressed distally; — both features which characterise the Torres Straits species, in which the insertion of the descending cryptocyst into the basal wall is as described by him.

The zooecia are oblong and are, on the whole, shorter than in *L. spatulata*. They are outlined by very distinct ridges (as seen after the removal of the frontal membrane). The horizontal cryptocyst is depressed and sharply separated from the narrow postoral shelf, which is only just distinguishable proximally, but is continued round the distal end of the zooecium. The whole free edge of this shelf is minutely beaded. In the region of the opesia the lateral walls have larger tubercles; and these give rise to the crenulate appearance described by Levinsen. The distal wall bears a number of smaller tubercles, but there is no single prominent tubercle, in this position, of the kind observed in *L. spatulata*. The horizontal cryptocyst is thick and is traversed by funnel-shaped pores, the basal ends of which are very small. Small, pearly granulations are scattered between the pores.

The tube may be median, but it is commonly nearer one side of the zooecium than the other, and may be very oblique (fig. 1). Its complete basal wall, described by Levinsen, is raised well above that of the zooecium; and, as its free edge may be separated from its frontal lip by an emargination on either side, the tube sometimes has the bilabiate character noticed by that author. The frontal lip bears small granulations, which may be arranged in longitudinal lines.

The lateral recesses are shallow, floored by an obliquely horizontal lamina which connects the tube, on either side, with the lateral wall of the zooecium, and is at some distance from the basal wall. The junction of the descending cryptocyst with the basal wall is, in the main,

a transverse line as described by LEVINSEN, but is usually double on one side, and occasionally on both sides (fig. 3). In the zooecia at the growing edge, the horizontal cryptocyst begins to develop at the proximal end, extending also along the sides as a narrower film; the free edge of the proximal and lateral parts forming, in its earlier stages, a curve which is strongly concave distally. Before the cryptocyst has reached the base of the future tube its descending lamina has appeared separately as a vertical plate given off by the basal wall of the zooecium, and extending along the lateral wall; the free, frontally directed edge being very concave. In most of the zooecia at this stage the descending cryptocyst is single on one side, but consists of two independent walls on the other, as in fig. 3, A; the two walls enclosing a part of the body-cavity. The further development consists in the union of the horizontal and descending cryptocysts, and in the outgrowth of the tube, with the formation of the floors of the lateral recesses. I have not ascertained the significance or the ultimate relations of the double part of the descending cryptocyst, nor whether the space between its two layers becomes closed or not. I think that the space in question opens permanently into the tube, on its basal side; and that it probably serves for the lodgment of a muscle.

The avicularium (fig. 1) is longer than a zooecium, its proximal cryptocyst being most depressed at the edge of the opesia. The part of the cryptocyst which forms the rostral floor is moderately flat; and, like the proximal part, it is finely granulated. It becomes most depressed towards the distal end, but this is partly due to the prominence of its oral arch. Parts of the terminal and lateral walls separating it from adjacent zooecia are visible on the frontal sides of its floor. Towards its free edge the rostral floor bears large tubercles, which project into the opesia and may give rise to a denticulate appearance. From the basal wall of the avicularium rises a transverse wall which has a free frontal edge, somewhat expanded at the middle. This may be regarded as the morphological equivalent of the descending cryptocyst of the zooecia which has not united with the horizontal lamina; but its free edge is at a level below that of the horizontal cryptocyst.

The opercula are yellowish in colour, the mandibles are somewhat darker, and the sclerites of both structures are brown. The mandible (fig. 2) is provided, on its distal border, with strong teeth.

2. *Labioporella spatulata* n. sp. (Pl. XXI, figs 4—6).

251. L. Stat. 315. Paternoster Is, N. of Sumbawa, 0—36 M. A single colony, encrusting a dead Lamellibranch shell.

Encrusting, zooecia oblong. Tube nearly median, with slightly concave free margin, usually complete basally, its frontal wall marked by longitudinal tuberculate ridges. Floor of lateral recesses as in *L. crenulata*. Horizontal cryptocyst extensive, finely tuberculate, porous. Postoral shelf narrow, minutely tuberculate, passing distally into a wider oral shelf, which is crenulate on its inner edge. A prominent tubercle, sometimes double or triple, commonly occurs on the distal wall, near its frontal end, within the oral arch. Avicularia large, with a prominent oral arch and a rostral floor short in the median line, owing to the extension of the opesia some distance beyond the condyles. Mandible elongate, spatulate, widening distally, with a well defined ∩-shaped main sclerite and bearing numerous minute teeth at its free margin.

The insertion of the descending cryptocyst into the basal wall is variable in character, some of the modifications being shown in fig. 4. The lateral walls of the tube are here thickened; and, with the outer part of the insertion of the cryptocyst, commonly form a T-shaped figure, on either side, as shown in fig. 4, C. By the proximal prolongation of the thickened lateral portions, the tube becomes longer than would be inferred from a frontal view. There is usually some asymmetry in the insertion of the two lateral walls of the tube, and this corresponds with the position of the polypide, the tentacles of which lie on that side of the zooecium which is nearer the wall of the tube. In the formation of the lateral recesses, the cryptocyst bends basally from the horizontal portion. Before it reaches the basal wall it is traversed, on each side, by a short horizontal and transverse ridge, which forms the floor of the lateral recess, and separates the origins of two muscles from one another.

The horizontal cryptocyst is provided with pores, between which are numerous minute tuberculations. A prominent tubercle, normally paired at a bifurcation of a row of zooecia, is present on the distal side of the oral arch, not far from the frontal surface. The rosette-plates are multiporous, as stated by Levinsen. There are two terminal plates, near the basal wall, and two on each of the lateral walls.

The avicularia (fig. 6) are large and have a prominent distal edge, continuous with lateral portions which form well marked condyles. Their opesia is pear-shaped and large, the rostral floor being crenulate on its inner edge. At the proximal end of the opesia, and at a lower level, is seen the free edge of a high, transverse, calcareous lamina, as in *L. crenulata*.

The opercula (fig. 6) are semicircular and small, not reaching any part of the oral arch, which has no condyles. They have a strong marginal sclerite, but no basal sclerite. A mandible is shown in fig. 5. The tentacles are not numerous and appear to be about 12. The wall of the stomach has many minute pigment-granules. The muscular system is strongly developed. From the lateral recesses arise two diverging bundles of depressor muscles (fig. 6), one passing proximally and the other distally, towards the frontal membrane. On the deep side of the floor of the lateral recess, in the socket between that lamina and the basal wall, rises another muscle, also shown in fig. 6. This passes towards the base of the operculum, and is probably a divaricator. The greater part of the space on the distal side of the descending cryptocyst is filled with a large mass of occlusor muscle-fibres (not shown in the figure), which are directed towards the operculum.

The avicularia have no polypide. Two occlusors are present on each side, the shorter pair originating from the basal wall, on the distal side of the transverse septum, and from the distal face of that septum. A pair of much longer muscles originate, beneath the cryptocyst, from the lateral wall, near the proximal end, and pass over the free edge of the transverse septum to the base of the mandible. A third mass of short muscles, probably divaricators, originates from the transverse septum, mainly from its free border, and is inserted partly into the base of the mandible and partly into the adjacent parts of the frontal membrane. Other muscle-fibres pass from the edge of the transverse septum to the frontal membrane, on the proximal side of the mandible.

A moderate number of the zooecia are provided with a lateral ovary, which is situated not far from the descending cryptocyst, on its proximal side, in the neighbourhood of the rectum

of the polypide. Other zooecia contain a mass of tissue which appears to consist of developing spermatozoa. As there is no trace of ovicells in this colony it may be inferred that these structures are not present; and this is probably typical of the genus.

3. *Labioporella bursaria* (MacGill.). (Pl. XXI, figs 12, 13).

Membranipora rosselii MacGillivray 1879 (nec Audouin), PZV, III, p. 34, Pl. XXVI, figs 4, 4*a*. Victoria; — 1882, PRSV, XVIII, p. 119, Plate, fig. 4.
Membranipora rosselii Haswell, 1880, PQC, p. 38. Queensland.
Amphiblestrum bursarium MacGillivray, 1887, PRSV, XXIII, p. 66, Pl. II, fig. 2. See also MacGillivray, 1885, PZV, XI, p. 21; and 1890, PZV, Index, under *Membranipora* and *Amphiblestrum*.
Membranipora bursaria, var. *phillipensis* Waters, 1898, JLS, XXVI, p. 690, Pl. XLIX, fig. 11. Port Phillip, Victoria.

364. E. Stat. 71. Makassar, S. W. Celebes, 0—32 M.

Cambridge, Mus. Zool.: —

Victoria, Port Phillip, E. C. Jelly, Reg. May 24, 1895.
BM Victoria, Port Phillip, Hincks Coll., Reg. May 13, 1899.
BM Queensland, Holborn Id, W. A. Haswell Coll., Australian Mus., Reg. Oct. 23, 1899.
BM (? sp.) Adelaide, 20—35 fath., J. C. Verco, Reg. Mar. 16, 1904.

British Museum: —

Victoria, Port Phillip Heads, J. B. Wilson, 88. 11. 14. 186.

Encrusting, zooecia oblong. Tube usually unilateral, sometimes with longitudinal ridges. Cryptocyst-shelf rather wider than in *L. spatulata*, with strong crenulations opposite the opesia. No single tubercle within the oral arch. Avicularia large, with a greatly developed rostral floor, shallow distally; the opesia large, oval, not extending much beyond the condyles, and not denticulate distally. Free edge of the transverse calcareous septum of the avicularium with an oval expansion. Mandible broadly spatulate, wider distally, where it is finely toothed; its basal sclerite broad, the two halves of its main sclerite hardly reaching beyond the proximal half and dying away distally.

In 1879 MacGillivray described a Victorian species, although with an expressed doubt as to his determination, as *Membranipora rosselii*, but his figure is unsatisfactory. In 1882 he gave a further description, with a better figure, in which an avicularium is shown; and he referred to a small rounded process, on one or both sides of the proximal end of the zooecium. The figure published by him in 1887 showed these processes more distinctly. Waters, in 1898, distinguished a var. *phillipensis*, from Port Phillip, Victoria, on the ground of the absence of the processes.

The Cambridge Collection includes two specimens from Port Phillip in which the processes in question are wanting, although they are represented in a third slide, which may belong to the same species, from Adelaide. This specimen is interesting in showing that the processes are not situated on a gymnocyst, as might be supposed. They appear to be enlarged tubercles of the cryptocyst, a gymnocyst not being present. The Siboga specimens agree with var. *phillipensis*

in the want of proximal tubercles. In view of the evidence given by the Adelaide slide I am not convinced that this varietal character is of much importance.

The rostral floor of the avicularium (fig. 13) is specially long, the opesia not extending much beyond the condyles, in which respect it differs specially from *L. spatulata*. From *L. crenulata* it is distinguished by the absence of denticulations on the distal edge of the avicularian opesia, by the greater proximal width of the rostrum and mandible, by the minute distal teeth of the mandible (fig. 12), and by the incompleteness of the main sclerite.

As evidence for the specific determination I rely principally on the two Victorian specimens in the Cambridge Collection. In Miss JELLY's slide the mandibles are wanting, but the avicularian opesia agrees with that of the Siboga specimens in the particulars noted above. In HINCKS' slide there is a single mandible, which agrees in shape and in the extent of the main sclerite with the Siboga specimen. The slide from Prof. HASWELL's Collection (not determined by him) has a single, abnormal avicularium, in which regeneration has taken place at the proximal end, the regenerated part being an ordinary zooecium (*Cf.* LEVINSEN, 1907, ODVSF, p. 154). The specimen from Adelaide has no avicularia, and its determination is thus doubtful. The Cambridge Collection also includes a species of this genus, with very large zooecia, from Japan (Owston Coll. 35. G (BM), and Mitsukuri Coll.). In the absence of avicularia I am unable to determine these specimens.

The opercula of *L. bursaria* resemble those of *L. spatulata*, but they seem to be a trifle longer. Their main sclerite is strong and dark brown in colour.

4. *Labioporella cornuta* n. sp. (Pl. XXI, fig. 7).

108. AC. Stat. 144. S. of Halmaheira (Djilolo), 45 M. One specimen, encrusting a coral.

Encrusting, zooecia oblong. Tube specially broad, its frontal lip produced into two horns, which unite with the lateral and basal walls of the zooecium. Lateral recesses reaching the basal wall. Cryptocyst-shelf narrow, the crenulations opposite the opesia small. Avicularia not found.

The characters of the tube and lateral recesses are sufficiently distinctive to justify the description of this specimen as a distinct species. The frontal lip of the tube is prolonged into a pair of lateral, obliquely vertical laminae, which join the basal wall with their deep edge and the lateral walls at their ends. The tube bears small tubercles, which may be arranged in obscure longitudinal lines. The lateral recesses differ from those of other species in having no independent floor, and they thus extend uninterruptedly to the basal wall. The cryptocyst-shelf is narrow. The opercula are light in colour, their main sclerites not brown.

The colony is developing a second layer, a process which is associated with the closing of the opesiae in the lower layer. A film of calcareous substance is formed in the periphery of the opesia, which it gradually occludes in an iris-like manner. Another calcareous film is formed more proximally, starting from the distal end of the horizontal cryptocyst and the base of the tube, dipping down into the lateral recesses, and later closing the tube. The zooecia subsequently developed in the upper layer may be orientated in directions quite different from those of the underlying series. Similar changes have been noticed in other species here described, and they may be referred to by WATERS (1898, p. 690) in *L. bursaria*.

5. *Labioporella thornelyae* n. sp. (Pl. XXI, figs 8, 9).

Siphonoporella bursaria (pars), Thornely, 1905, PGM, p. 111. Ceylon.

Cambridge, Mus. Zool.: —

BM Ceylon, L. R. Thornely, Reg. Apr. 25, 1906, 17.

Encrusting, zooecia shortly oblong, sometimes irregular. Tube wide, often not distinctly marked off from the floor of the shallow lateral recesses, sometimes incomplete basally. Oral arch more or less crenulate; several large tuberculations occurring within it, on the distal wall. Avicularia elongate, their distal portion relatively narrow, with a floor greatly depressed proximally. Mandible narrow proximally, wider distally; its basal and lateral sclerites very broad; the distal border bearing a row of relatively large, incisor-like teeth.

This species is based on some of the material from Ceylon which has been described by Miss Thornely as *Siphonoporella bursaria*. Its characters are well marked, particularly those of the avicularia, which differ in important respects from those of other species. They occur in considerable numbers, and are generally related to the oral arch of a zooecium in the way shown in fig. 8, being sometimes slightly asymmetrical. The rostral floor seems to be completely absent; the distal part of the avicularium overlapping the next zooecium, from which it is separated by its thin basal wall, through which can be seen indications of the underlying zooecium. This part of the avicularium is relatively narrow, particularly in the region of the condyles, which are well developed. The avicularium possesses a vertical, transverse septum, as in other species.

The mandible (fig. 9) is very peculiar, particularly in its strong lateral and basal sclerites. The teeth are unlike those of other species, being closely set, the distal ones incisor-like and extending round the widened part of the mandible.

The tube of the zooecia (fig. 8) is often only obscurely separated from the floor of the lateral recess, on either side. It is sometimes more obviously distinct than in the figure; but the lateral recesses are always shallow. The frontal wall of the tube bears strong tubercles, and others of the same kind are present in a group inside the oral arch, near the frontal end of the distal wall. The cryptocyst generally is tuberculate, as in other species; and the inner border of the cryptocyst-shelf is usually denticulate.

A second layer of zooecia is being produced, as in some of the other species.

Fam. 3. Thalamoporellidae.

Thalamoporellidae Levinsen, VMNFK, 1902, p. 21; — 1909, MSSB, pp. 89, 175.
Thalamoporellidae Canu and Bassler, 1920, USNMB, 106, p. 268; — 1923, USNMB, 125, p. 60.

The characters of the Family have been given by Levinsen, but special attention may be called to the remarkable, internal, calcareous spicules, the adoral areas and their tubercles, the more or less asymmetrical opesiules, and the vicarious avicularia, either rounded or pointed. Peculiar globose ovicells, composed of two valves separated by a median septum, are known to occur, on the distal side of the orifice, in some species of *Thalamoporella*.

Canu and Bassler (1920) included in this Family two genera, *Woodipora* and *Manzonella*, founded by Jullien (1888, CH, pp. 78, 79) on fossil species. *Woodipora* was proposed for *Membranipora holostoma* Searles Wood, doubtless on the basis of the description given by Busk (1859, FPC, p. 36). *Manzonella* was suggested for *M. exilis* Manzoni (1869, SAWW, LIX, 1, p. 512). The Family diagnosis given by Canu and Bassler appears to be based on the characters of the recent species.

Levinsen referred all the recent species to *Thalamoporella*, but in doing so he ought to have employed the earlier generic name *Thairopora*. As I think it desirable to separate these two genera I indicate shortly the distinguishing characters of *Thairopora*, citing some of the more important papers in which its species have been described. These are specially characteristic of the southern coast of Australia.

1. **Thairopora** MacGill. (not represented in the Siboga Collection).

Diplopora MacGillivray, 1881, PRSV, XVII, p. 15 (nec auctt. [1])).
Thairopora MacGillivray, 1882, PRSV, XVIII, p. 118.
Diploporella MacGillivray 1885, PRSV, XXI, p. 98; to replace *Diplopora* MacGill., pre-occupied.
Pergensina Jullien, 1888, CH, p. 79.

Jullien indicated "*Flustra mamillaris* Lamouroux, Hincks" as the genotype of *Pergensina*, thus accounting for one of the four species originally included by MacGillivray in *Thairopora*, for which I now select *Membranipora dispar* MacGill. as the genotype. As MacGillivray's four species were probably referred correctly to a single genus, *Pergensina* must be regarded as a synonym of *Thairopora*.

In general characters *Thairopora* agrees with *Thalamoporella*, and the three species of which Levinsen gives an account have spicules, as in that genus. The opesiules, which have not been described in all the species, are (when present) very unequal in size, and the smaller one may disappear (Levinsen, 1909, p. 194). The larger opesiule differs from that of *Thalamoporella* in being transversely slit-like, often oblique; and a number of denticles commonly project across it from its proximal wall. The cryptocyst is transversely depressed at about the middle of the zooecium, and the polypide-tube commences at a great distance from the frontal membrane, rising steeply to the orifice. The cryptocyst is usually divided into four "segments" (as described by Levinsen), separated by ridges; — a proximal and distal portion extending across the whole width of the zooecium, and two lateral portions between them meeting in a median suture. The avicularia are of the pointed type, in the species of which satisfactory descriptions have been given. Ovicells are unknown.

Species referable to *Thairopora*.

Thairopora dispar (MacGill.).

(?) *Flustra concentrica* Lamouroux, 1816, PCF, p. 108.

1) This name has been introduced for at least three other genera of Polyzoa, as follows: —
Diplopora Schaffhäutl, 1863, "Süd-Bayerns Lethaea Geognostica", pp. 324—328.
Diplopora Young and Young, 1876, Proc. Nat. Hist. Soc. Glasgow, II, Part II, p. 327. Nickles and Bassler (1900, SAFB, p. 233) proposed *Diploporaria* for this pre-occupied name.
Diplopora Jullien and Calvet, 1903, BCH, p. 115.
These are all pre-occupied by *Diplopora* Link, 1807, Beschr. Nat. Samml. Univ. Rostock (4), p. 25. See Sherborn, IA, p. 1945.

Membranipora dispar MacGillivray, 1869, PRSV, IX, p. 131. Portland Bay (Victoria); — 1879, PZV, III, p. 32, Pl. XXVI, figs 1—1*b*.
Thairopora dispar MacGillivray, 1882, PRSV, XVIII, p. 118.

Thairopora mamillaris (MacGill.) (? Lamx).

(?) *Flustra mamillaris* Lamouroux, 1816, PCF, p. 110, Pl. I, figs 6*a*, *B*. "Sur le *Zostera Australis*, de l'Australasie".
Membranipora mamillaris MacGillivray, 1860, TPIV, IV, p. 165, Pl. II, fig. 3. Queenscliff (Victoria); — 1879, PZV, III, p. 30, Pl. XXV, figs 4—4*a*.
Membranipora mamillaris Hincks, 1880, AMNH, 5, VI, p. 88, Pl. X, fig. 9.
Thairopora mamillaris MacGillivray, 1882, PRSV, XVIII, p. 118, figs 7, 7*a*; — 1890, PZV, XX, p. 351, Pl. 196, fig. 2.
Thairopora mamillaris Hincks, 1891, AMNH, 6, VIII, p. 92.
Pergensina mamillaris Jullien, 1888, CH, p. 79.
Thalamoporella mamillaris Levinsen, 1909, MSSB, pp. 179, 194, Pl. VIa, figs 5*a*—*e*.

Thairopora armata (MacGill.).

Membranipora armata MacGillivray, 1869, PRSV, IX, p. 131. Port Phillip (Victoria).
Thairopora armata MacGillivray, 1882, PRSV, XVIII, pp. 117, 118, figs 6, 6*a*; — 1890, PZV, XX, pp. 351, Pl. CXCVI, fig. 1.

Thairopora woodsii (MacGill.).

Membranipora woodsii MacGillivray, 1869, PRSV, IX, p. 130. Portland Bay (Victoria); — 1879, PZV, III, p. 33, Pl. XXVI, figs 2—2*b*.
Thairopora woodsii MacGillivray, 1882, PRSV, XVIII, p. 118.

Thairopora jervoisii (Hincks).

Steganoporella jervoisii Hincks, 1880, AMNH, 5, VI, p. 381, Pl. XVI, figs 5, 5*a*. Adelaide.
Thairopora jervoisii MacGillivray, 1887, PRSV, XXIII, p. 67, Pl. II, fig. 1; — 1890, PZV, XX, p. 352, Pl. CXCVI, fig. 3.
Thalamoporella jervoisi Levinsen, 1909, MSSB, pp. 178, 193, Pl. VIa, figs 4*a*—*d*.

Thairopora cincta (Hutton).

(?) *Cellepora alata* Lamouroux, 1821, EM, p. 2, Pl. LXIV, figs 10, 11. "Australasie, terre de Lewin".
Membranipora (?) *cincta* Hutton, 1878, PPRST for 1877, p. 23. St Vincent's Gulf, South Australia.
Membranipora transversa Hincks, 1880, AMNH, 5, VI, p. 89, Pl. XI, fig. 9. Australia; — 1881, AMNH, 5, VII, p. 154.
Diplopora cincta MacGillivray, 1881, PRSV, XVII, p. 15, figs 1—1*c*. Victoria.
Diploporella cincta MacGillivray, 1885, PRSV, XXI, p. 98.
Thalamoporella cincta Levinsen, 1909, MSSB, pp. 179, 192, Pl. XXII, figs 7*a*—*d*.

Thairopora whittelli MacGill.

Thairopora whitttelli MacGillivray, 1889, TRSSA, XII, p. 27, Pl. II, figs 2—2*b*. South Australia.

2. **Thalamoporella** Hincks (Pls XIX, XX).

Thalamoporella Hincks, 1887, AMNH, 5, XIX, p. 164.
Thalamoporella Levinsen, 1909, MSSB, p. 178.
Genotype, indicated by the author, *Flustra rozieri* Audouin, 1826, EPS, p. 239.

Zooecia with a depressed, porous cryptocyst, generally less sunk than in *Thairopora*, perforated by two asymmetrical opesiules, which are rounded and not slit-like. Opesia and orifice practically co-extensive. Opesiules meeting either the basal or the lateral walls; their median walls assisting in the formation of the characteristic polypide-tube, which terminates beneath the orifice. Internal spicules present, in the form of "compasses" or "calipers", or both. Avicularia vicarious, of either the rounded or the pointed type. Ovicells (not known in all the species) very globose and prominent, the cavity between the ectooecium and the entooecium divided by a median suture.

Distribution distinctly less southern than that of *Thairopora*.

Hincks (1887) was the first to recognise the peculiar structural features of *Thalamoporella*, of which he gave a succinct diagnosis. Our knowledge of the genus was greatly enlarged by Levinsen, who first (VMNFK, 1902, p. 21) called attention to the remarkable spicules, of a kind not known to occur outside this Family. He described two forms, under the names, respectively, of "bows" and "compasses". The first kind are termed "curves" in his later Memoir (1909), but I venture to suggest "calipers" as more appropriate to their form, and I give a possible explanation of the function of the spicules below, under *T. rozieri*. In this Memoir (pp. 175—195) Levinsen gave an admirable account of the Family, distinguishing several new species and varieties of *Thalamoporella* on characters of the spicules, the mode of insertion of the opesiules and the extent to which the basal sclerite of the operculum is developed. He unfortunately complicated the synonymy, as I think, by an incorrect identification of *T. rozieri*, the type-species.

The cavities of the opesiules of *Thalamoporella* correspond with the lateral recesses of *Steganoporella*. They do not remain open distally, as in most species of that genus, but become closed by the formation of a pair of processes which connect the distal margin of the polypide-tube with the lateral walls of the zooecium. These are horizontal laminae, and on their basal side each opesiule opens freely into the distal body-cavity, in certain cases, but by a foramen (Pl. XX, fig. 4) if it has become converted into a tubular structure.

The opesiule is a vertical cylinder with an incomplete distal wall, extending from its frontal opening to the neighbourhood of the basal wall, or reaching that wall; and its median wall is common to it and the polypide-tube. In species in which both opesiules have an insertion-line on the basal wall (Pl. XIX, fig. 17), a transverse section of the zooecium would show the polypide-tube as a ∩ resting on the basal wall. Distally to the commencement of the opesiules, the tube would merely have a roof and sides, formed by part of the cryptocyst. In some cases (Pl. XX, fig. 1) the two distal limbs of the insertion-line are closely approximated; the cavity of the opesiule having extended partially round the basal side of the polypide-tube, which thus has a nearly complete wall. If the opesiules are still further extended, so as to unite basally, the polypide-tube becomes complete, as in species of *Steganoporella* (Pl. XVII, figs 1, 10). In some cases the smaller opesiule unites with the lateral zooecial wall, and the basal wall then shows only one insertion-line (Pl. XIX, fig. 19); and sometimes both opesiules unite with the lateral walls.

The opesiules are always more or less unlike, and Canada balsam preparations show that this asymmetry is related with the position of the polypide in the body-cavity. The retracted tentacles always lie on one side of the zooecium (Pl. XX, fig. 8), and the greater part of the

alimentary canal on the other side. Each opesiule contains one of the depressor muscles, which originate on or near the basal wall, their tendons running through the opesiules to the frontal membrane. The body-cavity is much occupied, on one side, by the tentacles, which interfere with the free action of the depressor of their side. The retracted alimentary canal lies mostly at the proximal end of the zooecium; and the cavity is unoccupied distally. This is probably the explanation of the asymmetry, in this and other genera; and in *Thalamoporella* the larger opesiule, which contains a larger muscle, corresponds in fact with the side containing the alimentary canal. This arrangement can be inferred from the direction of the polypide-tube (see Pl. XIX, fig. 22); and it is thus possible to conclude from the calcareous parts alone that the smaller opesiule belongs to the side occupied by the tentacles.

The avicularia (Pl. XIX, fig. 5) of *Thalamoporella* are readily comparable with the "B" zooecia of *Steganoporella*, but they have become definitive vicarious avicularia without polypides. Two types can be distinguished, respectively possessing rounded and pointed mandibles, and I believe these to represent the two types of "B" zooecia of *Steganoporella*, with ∩-shaped and Λ-shaped main sclerites respectively. The raised distal portion of the avicularium seems to be formed by a modification of the adoral tubercles, as is shown by the relations of the large adoral cavities (Pl. XIX, fig. 5, Pl. XX, fig. 7). A similar structure is illustrated by Levinsen (1909, Pl. VI *a*, fig. 5 *c*), in *Thairopora mamillaris*, and is well shown in examples of this species and of *T. armata* in the British Museum collection.

The occurrence of globose ovicells would hardly have been expected in a genus allied to *Steganoporella*, but their structure points to the conclusion that they are not homologous with the hyperstomial ovicells of other Cheilostomes. Under *Thalamoporella rozieri* I give reasons for believing that they are modifications of the adoral tubercles. The adoral areas of the gonozooecia are specially large (Pl. XIX, fig. 6), and each gives rise to a curved valve which grows over the frontal surface, uniting with its fellow of the opposite side in a median suture, which is persistent (fig. 4). The ovicells are nearly always imperforate, although the entooecium appears to be sometimes incompletely calcified. *T. harmeri* Levinsen (1909, p. 186, Pl. VI *c*, fig. 1 *a*) has ovicells with large pores. Waters (1907, JLS, XXX, p. 129; — 1909, XXXI, pp. 124, 142) has shown that the ovicell may contain two or even three embryos; a most unusual occurrence in Cheilostomata.

The spicules and the opercula are described under the several species; and I agree with Levinsen that these structures afford specific characters of great value. They have not been made use of in papers preceding Levinsen's careful study (1909), and it is thus difficult to place many of the earlier records in the synonymic lists. The distribution of the species of *Thalamoporella* can only be ascertained by a renewed examination of material from some of the known localities. The genus has a wide distribution, although it is not restricted to the Southern Hemisphere, as stated by Waters (1904, BB, p. 8 n). Although overlapping *Thairopora*, it is distinctly less southern than that genus; and it is well represented in the Siboga area.

Key to the species of *Thalamoporella* here recorded.

1	Avicularia with mandibles rounded distally	2.
	Avicularia with mandibles pointed distally	6.

2	Vincularian. Calipers absent. The larger opesiule alone (in most cases) reaches the basal wall in a closed insertion	2. *T. novae-hollandiae.*
	Generally encrusting. Calipers present. Both opesiules meet the basal wall	3.
3	Basal insertions of opesiules closed. Mandibles with fine teeth distally.	1. *T. rozieri.*
	Basal insertions of opesiules open distally. Mandibles not toothed	4.
4	Avicularia and their sister-zooecia asymmetrical distally .	3. *T. granulata.*
	Avicularia and their sister-zooecia not asymmetrical distally	5.
5	Calipers stirrup-shaped, higher than wide	4. *T. stapifera.*
	Calipers not stirrup-shaped, wider than high	5. *T. tubifera.*
6	Opesia with a well developed sinus	7.
	Opesia with a straight proximal margin, not distinctly sinuate	8.
7	Encrusting or bilaminar, not jointed. One opesiule meets the basal wall in a closed insertion	8a. *T. gothica*, var. *indica.*
	Cellariiform (rarely encrusting). Basal insertion of opesiules variable	8b. *T. gothica*, var. *prominens.*
8	Operculum very large, its main sclerite far removed from the margin, the orifice enlarged distally by a transversely crescentic portion overlapping the next zooecium. . .	6. *T. expansa.*
	Operculum small, orifice semicircular, normal, not enlarged. Rostrum of avicularium long, directed obliquely distally	7. *T. hamata.*

1. *Thalamoporella rozieri* (Aud.). (Pl. XIX, figs 3—13).

Flustra? *rozieri* Audouin, 1826, EPS, p. 239; 1828, p. 66. (Egypt.); SAVIGNY, DE, Pl. VIII, figs 9^1, 9^2.

nec *Thalamoporella rozieri* Levinsen, 1909, MSSB, p. 181.

Thalamoporella rozieri Waters, 1909, SRS, p. 141, Pl. XV, figs 12—15. Red Sea; — 1918, JLS, XXXIV, p. 13, Pl. IV, figs 9*a*—*c*. Cape Verde Is.

Steganoporella smittii Hincks, 1880, BMP, p. 178, Pl. XXIV, figs 5, 6. Cornwall, England.

Thalamoporella smittii Hincks, 1887, JLS, XXI, p. 123. Mergui Archipelago, Burma.

Thalamoporella smittii Thornely, 1907, MPIM, p. 187 (no description). Pedro Shoal (Indian Ocean?).

364. F. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
390. I. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.
349. A. Stat. 240. Banda, Banda Sea, 9—45 M.

Encrusting. Cryptocyst, including the wall of the polypide-tube, granulated. Opesia terminal, with a broad proximal sinus, the adoral regions usually without tubercles, which may, however, be present. Opesiules large, not very different in size, both reaching the basal wall in a closed insertion. Opercula with incomplete basal sclerite. Mandibles elongate, varying in size, the distal margin rounded and toothed, the main sclerite consisting of two parallel, approximated bars for

the greater part of its length. Ovicells large, prominent, wider than long, the orifice in the form of a gothic arch, extending about half the length of the ovicell. Spicules, long and short compasses and small calipers.

I regret that I cannot regard the specimens elaborately described by LEVINSEN as *T. rozieri* (five named varieties being distinguished) as referable to AUDOUIN's species. WATERS (1918, p. 13) has stated that the form from the Red Sea described by him in 1909 must be considered identical with the one well figured by SAVIGNY. Both are from nearly the same locality (if SAVIGNY's specimens were from the Red Sea), and I can confirm WATERS' view by comparison of the Siboga specimens with his figures and those of SAVIGNY. The avicularia in my material agree closely with those figured by WATERS (1909). These structures were not found by SAVIGNY, who gave an admirable figure of the ovicells; and with this my own correspond in the form of the orifice and in its extension to about the middle of the ovicell. Among the varieties placed by LEVINSEN in *T. rozieri*, var. *californica* (Pl. VIb, fig. 2*b*), from California (BM), is the only one in which ovicells are mentioned or figured. Their orifice does not appear to extend beyond the first quarter of the length of the ovicell. WATERS (1918) expressly states that his specimens from the Cape Verde Is belong to the same species as his Red Sea material, and this conclusion is confirmed by the basal insertions of the opesiules and by the spicules, which are long and short compasses and calipers.

The adoral areas, which occur on either side of the opesia (or orifice) appear to be splits formed in the frontal region of the lateral and distal walls. Their inner vertical walls constitute most of the oral arch, and their outer walls are parts of the lateral and distal walls of the zooecium. In a young zooecium the condition of the surface is at first Membraniporine, a frontal membrane closing the entire body-cavity, and no cryptocyst being present. The future orifice early becomes evident, by the formation of a slight thickening, on each side, of the calcarous wall. In this a cavity makes its appearance, extending into the rounded adoral tubercle of its side, when this is present. The tubercles do not, as a rule, occur in *T. rozieri* but are seen in the uppermost zooecium in fig. 4. When they are wanting the adoral areas are hardly distinguishable, or exist merely as the convex regions sloping up to the margin of the orifice; both conditions being shown in fig. 4. When the tubercle is vestigial the cavity is reduced to a narrow longitudinal slit, but when more developed the cavity is wider in proportion.

The ovicells, which occur in specimens from all the localities, may be regarded as modifications of the adoral tubercles. A fertile zooecium may be recognised, even at an early stage, by having an orifice considerably longer than that of an ordinary zooecium, as well as by the situation of the proximal walls of its opesiules near the proximal wall of the zooecium (fig. 6). The adoral areas in the young fertile zooecium contain a wide cavity resembling that of other zooecia, but considerably longer. These two adoral cavities nearly meet one another, but are separated by a calcareous septum, representing the wider region between the cavities in non-fertile zooecia. The modified tubercles which form the two halves of the ovicell are curved valves, derived from the walls of the adoral cavities (fig. 6). These grow over the frontal surface and meet in a persistent median suture. The ectooecium and entooecium are the two curved surfaces of these flattened tubercles. A polypide is developed in the gonozooecium, which has an ovary near the middle of the basal wall, near the proximal end of the distal half.

The ovicells of *Thalamoporella* have a striking resemblance to those of *Alysidium parasiticum* Busk, as described by LEVINSEN (1909, pp. 66, 203, Pl. VII, figs 3 *a*, *e*, *h*—*n*) a species widely differing from *Thalamoporella* in its zoarial characters. The ovicell of *Alysidium* also develops as a pair of curved valves arising from adoral cavities, restricted however to the sides of the orifice, and thus not separated from one another by a calcareous septum (LEVINSEN, figs 3 *e*, *h*). It is further noteworthy that the ooecial valves of this species replace a pair of tubercles borne by the ordinary zooecia. The existence of the same type of ovicell in two very different, but related, Families, is a fact of much interest.

The diagrammatic longitudinal section of an ovicell of *Thalamoporella* given by LEVINSEN in Pl. XXIV, fig. 14 appears to be correct in showing that the ovicell is closed by an operculum which is "connected at its base with the operculum of the gonozooecium" (p. 176). In the young gonozooecium the operculum lies in the plane of the frontal membrane and has the form shown in figs 6, 12. When the ovicell has been completed, its orifice lies in an ascending plane in which is situated an operculum, lying externally to the zooecial operculum, of which it is perhaps a part (see Pl. XIX, fig. 22, *T. stapifera*), and strengthened laterally by strong sclerites which lie close to its margin.

The zooecia (Pl. XIX, fig. 4) of *T. rozieri* have the general characters found throughout the genus. They are elongated and rectangular, with well raised margins. The cryptocyst, including the polypide-tube and its unions with the lateral wall, is uniformly granular, and more than its proximal half is perforated by small pores. The opesiules are large and generally unlike. Both reach the basal wall, and in basal view (figs 9, 10) the asymmetry is usually marked; one being larger and rounded, and the other being subtriangular, although some variation may occur. The occlusor muscles of the operculum originate from the basal wall immediately on the distal side of the insertions of the opesiules, and probably to some extent from the distal walls of the opesiules, each of which opens into the body-cavity by a foramen on its distal side (fig. 4, L. gonozooecium). In the gonozooecia the opesiules are specially long and commence near the proximal end. In development (figs 9, 10) the basal insertion of the opesiule is first completed proximally and later becomes closed distally.

An avicularium may occur as the first member of an intercalated row of zooecia (fig. 9), and is more or less pointed proximally (fig. 5). Its opesia is large and undivided, the mandible articulating with a condyle on each side. The cryptocyst is imperforate, and the oral shelf is large. The oral arch, which varies in length, is nearly semicircular distally, its sides curving inwards proximally. The mandible bears a row of fine teeth distally (fig. 5) and is strikingly like that of species of *Steganoporella*. The main sclerite consists of two parallel bars, widely removed from the edge, diverging proximally to join the ends of the basal sclerite (fig. 8).

The opercula (fig. 11) do not extend into the sinus of the opesia and have no complete basal sclerite, but the outer parts of this structure are indicated, as in *Steganoporella*, by two short sclerites directed towards one another from the proximal ends of the main sclerite. The original operculum of a gonozooecium is represented in fig. 12, and is considerably longer than the ordinary opercula.

The spicules (figs 3, 7), which are found in all parts of the body-cavity and in all the colony-units, are of two kinds; — the "compasses", long or short, nearly straight spicules, with

a slight projection, near the middle, on one side; and the "calipers", which differ from the compasses in having arms incurved at their free ends.

The spicules have so much resemblance to those of certain Sponges and Holothurians as to suggest the idea that they are foreign inclusions. There can be no reasonable doubt, however, that they really belong to the Polyzoon, although no explanation of their purpose appears to have been advanced. An observation made on this species may give a clue. The growing margin of 349. A is crowded with large numbers of long compasses, mostly arranged longitudinally, while in the older zooecia spicules are much less numerous. I suggest the possibility that the spicules are temporary deposits of calcareous material which can be used later in the construction of zooecial walls. Evidence that they can be absorbed is not conclusive, but some support is given to this view by certain cases in which the arms of the compasses seem to be abbreviated, by the smaller number of spicules found in the older zooecia, and by the fact that the zooecial walls are formed at the growing margin with no reference to the position of the spicules, and in such a way that an individual spicule may be seen with its two ends in different zooecia. This condition is transitory, and I do not find spicules thus situated in fully formed zooecia. Some indication of the mode of development of the spicules is given below under *T. gothica*, var. *indica*.

The tentacles are about 20—22.

2. *Thalamoporella novae-hollandiae* (Hasw.). (Pl. XIX, figs 14—16, 18, 19; text-fig. 11).

Vincularia novae-hollandiae Haswell, 1880, PLSNSW, V, p. 41, Pl. III, fig. 3. Queensland.
Thalamoporella rozieri (pars) Waters, 1887, AMNH, 5, XX, p. 186. Torres Straits, 10—30 fath.
Thalamoporella novae-hollandiae Waters, 1918, JLS, XXXIV, p. 13.
Thalamoporella novae hollandiae Levinsen, 1909, MSSB, pp. 179, 185, Pl. VIa, figs 3*a*—*f*.

291.A. Stat. 273. Jedan, Aru Is, 13 M.
417.A. Locality not recorded.

Cambridge, Mus. Zool.: —

BM Torres Straits, 3, 35, 149. A. C. Haddon, Reg. Feb. 24, 1898.

The Cambridge specimens here referred to have already formed the material for Levinsen's excellent account of this species.

Typically erect and tubular, rarely encrusting. Cryptocyst granulated, with conspicuous thickened margin laterally, pores relatively large. Opesia with a very wide proximal sinus, the condyles minute. Operculum with a complete basal sclerite, much curved. Adoral areas and their cavities vestigial, without tubercles. Opesiules large, unlike, the larger one alone typically reaching the basal wall. Avicularia large, with elongate, rounded, toothless mandibles, the two halves of the main sclerite not closely approximated. Distal end of the sister-zooecium of an avicularium usually conspicuously asymmetrical. Ovicells unknown. Spicules long and short compasses.

The habit of *T. novae-hollandiae* is very distinctive, the zoarium consisting of erect, tubular, unilaminar branches, varying from 1.7 to 4 mm. in diameter (text-fig. 11). The branches bifurcate at intervals of about 10—15 mm., and may anastomose later so as to form a closed mesh. After the bifurcation the branch is nearly cylindrical, but it becomes flattened before its

next bifurcation. The zooecia open all round, on the outer side of the tube. The Torres Straits specimen 35, which is referred to by LEVINSEN, was encrusting.

The adoral areas are vestigial, and their cavities are hardly discernible in the fully calcified zooecium, but a very narrow cavity can be seen in the young condition. The sinus of the opesia (fig. 16) is much wider than in *T. rozieri*, and the condyles are very minute. As pointed out by LEVINSEN, only the larger opesiule typically meets the basal wall, where it is directed proximally and has a rounded form, usually expanded in a trumpet-like manner before it reaches its insertion (fig. 19). As in other species, the larger opesiule belongs to the side containing the alimentary canal. In some cases both opesiules reach the basal wall, one being smaller than the other at its insertion; and in other cases neither opesiule reaches the basal wall. The fenestra placing the opesiule in communication, distally, with the general body-cavity is very large, and is easily seen in this species, as its direction is less vertical than in *T. rozieri*. It occurs near the frontal surface and is shown in one of the opesiules of fig. 16. The operculum (fig. 14) differs from that of *T. rozieri* in having a complete basal sclerite. It is obvious from its shape than it only partially fills the opesia.

Fig. 11. — *Thalamoporella novae-hollandiae.* Fragment of zoarium (291. A[1]), natural size.

The curious asymmetry of the sister-zooecium of the avicularium (fig. 16) was not noticed by LEVINSEN, though it is conspicuous in the Torres Straits slide 3, one of those examined by him. The transverse diameter of the opesia is usually inclined towards the avicularium at an angle of about 45°, but in other cases (occasionally in 291. A) it may be almost parallel with the long axis of the zooecium, so as to depart from the normal position by nearly 90°. The avicularium differs from that of *T. rozieri* in the less inflected lateral walls, in the greater separation of the two halves of the main sclerite of the mandible and in the absence of distal teeth.

The spicules are long and short compasses; calipers being absent, as pointed out by LEVINSEN. In the small compasses the angle between the two halves is variable, and may be hardly more than a right angle.

No trace of ovicells has been observed in this and in certain other species, and it cannot be assumed that they are ever developed, in these cases. This may be correlated with the greatly reduced condition of the adoral areas.

Thalamoporella granulata Levinsen.

LEVINSEN, who introduced this species in 1909 (pp. 178, 188), described three varieties, which he distinguished as var. *stapifera*, var. B, and var. *tubifera*. With the exception of a specimen of the first variety, they were based exclusively on material belonging to the Cambridge Museum. From a re-examination of the type-material I have come to the conclusion that all three varieties represent distinct species; and, further, that the character alluded to in the name *tubifera* is due to a secondary process of calcification, which cannot be expected to occur in young zooecia. The three "varieties" agree in the fact that both opesiules reach the basal surface, in the occurrence of both compasses and calipers, and (unless var. B is an exception) in the absence of a basal sclerite in the opercula. They differ from one another in the characters

of the avicularia, ovicells and spicules and in the form of the opesia. As LEVINSEN designated no type I propose that the name *granulata* be restricted to his "var. B", and that his two varietal names be given specific rank. *T. granulata* Canu and Bassler, 1919 (CIW, 291, p. 88, Pl. II, fig. 14), from the Miocene of Santo Domingo, can hardly be referred to any of these species.

3. *Thalamoporella granulata* Lev. (restricted).

Thalamoporella granulata, var. B, Levinsen, 1909, MSSB, p. 189, Pl. VIa, figs 1*a—f*. Torres Straits.

(?) *Thalamoporella rosieri* form *longirostrata* Maplestone, 1900, PRSV, N. S., XIII, p. 5, Pl. II, fig. 14. Tertiary, Victoria.

T. granulata Osburn (1914, CIW, 182, p. 197), from the Tortugas Is. Florida, in which the proximal cryptocyst of the avicularium reaches the hinge-line, appears not to belong to this species.

Cambridge, Mus. Zool: —

BM Type (described by LEVINSEN). Torres Straits, 161, A. C. HADDON, Reg. Feb. 24, 1898.

Encrusting or Vincularian. Adoral areas and their cavities vestigial, without tubercles. Pores of cryptocyst relatively few. Opesiules asymmetrical, both typically reaching the basal wall, their insertions variable and incomplete distally. Avicularia large, elongate, with a rounded, asymmetrical, distal end; the floor of the rostrum extensive and not much depressed. Sister-zooecium of the avicularium with a slightly asymmetrical opesia. Calcareous septum on the distal side of the opesia of the gonozooecium long. Spicules long and short compasses, the latter with their two arms often meeting at an angle of about 135°; the calipers very small and typically wider than long.

The figure of the fossil described by Maplestone agrees with the type in the form of the avicularium and in the asymmetry of its sister-zooecium.

In fig. 1 *a* LEVINSEN represented the avicularium, which, as is usual in this genus, forms the first member of a new row of zooecia; and he also showed the asymmetrical character of its sister-zooecium. Fig. 1 *d* shows the broadly spatulate mandible, the two halves of the main sclerite approximated and parallel for nearly their whole length. In its present condition the specimen has no complete mandibles or opercula. The basal insertions of the opesiules are more variable than as shown by LEVINSEN (fig. 1 *b*); and, in addition to the arrangements there represented, I find that one opesiule occasionally fails to meet the basal wall, and that in other cases the two parallel free ends of the insertion-lines may be more widely separated. In another instance the two insertion-lines meet, so as to form an irregular transverse line across the basal surface.

The oral shelf of the zooecial opesia is fairly large and its sinus is well marked, that of the gonozooecium being wide and shallow. The two adoral cavities from which the ovicell-valves develop are narrow proximally and wider distally, where they are separated by an elongate calcareous septum (LEVINSEN, fig. 1 *c*), which is much longer than in *T. rozieri*. In one ovicell the wall of the entooecium has a large fenestra on the frontal side, in each valve; and I think that the calcification of this wall is typically incomplete.

4. *Thalamoporella stapifera* Lev. (Pl. XIX, figs 17, 20—25).

Thalamoporella granulata, var. *stapifera* Levinsen, 1909, MSSB, p. 188, Pl. VI, figs. 5*a—e*.

290. B. Stat. 279. Roma Id, N. E. of Timor, 36 M. (On a Sponge).

Cambridge, Mus. Zool.: —

BM Co-type. On *Tridacna*, locality unknown, G. M. R. LEVINSEN, Reg. Sept. 11, 1900, 3.

The specimen from *Tridacna* is part of the material on which LEVINSEN founded his var. *stapifera*; and I designate it a co-type, with the other co-types, presumably in the Copenhagen Museum, from the same source. LEVINSEN's description was based partly on a specimen from the Andaman or Nicobar Islands.

Encrusting. Adoral areas usually vestigial, occasionally with an indication of a tubercle. Zooecia large, sometimes of a rounded hexagonal form. Cryptocyst much granulated, with large pores. Opesiules asymmetrical, both reaching the basal wall, their insertion incomplete distally. Avicularia large, symmetrical, the rostrum long, narrow, with parallel sides, its floor occupying more than half of its length; the proximal cryptocyst little developed; the sister-zooecium not asymmetrical. Zooecial opesia with a large, sharply marked sinus, the condyles larger than usual. Basal sclerite of operculum incomplete. Calcareous septum on the distal side of the opesia of the gonozooecium rather short. Compasses mostly small, the two arms usually meeting at an angle of more than 135°. Long compasses small, with a larger angle. Calipers longer than wide.

The Siboga specimens have no avicularia, the description of which is taken from the specimen presented by LEVINSEN.

T. stapifera seems to be entitled to specific rank, from the characters of its calipers, avicularia and opesia. The zooecia (fig. 25) are large, and the sinus of the opesia is deep and distinctly limited by the strong condyles. The basal insertions of the opesiules (fig. 17) show less variation than in *T. granulata*, but they are, as usual, unlike on the two sides. The distally directed limbs of the hook-like insertion-lines may be separated by the full width of the polypide-tube, the basal wall of which is then part of that of the zooecium. When they are more closely approximated, this is generally due to the fact that the larger opesiule grows to some extent beneath the polypide-tube, which thus has a partially independent basal wall. The end of the hook-like inner wall of the opesiule may turn outwards, so as to project laterally beyond the wall of the polypide-tube. This condition is seen, on both sides, in the gonozooecium, fig. 24, but it may also occur in ordinary zooecia.

The avicularia differ from those of *T. granulata*, particularly in the narrow, symmetrical rostrum, and in the great length of its distal floor. The calcareous septum between the two valves of the ovicell (fig. 21) is short, although rather longer than in *T. rozieri*. Fig. 22 shows the double operculum of the gonozooecium and ovicell characteristic of the genus.

The spicules are very distinctive, particularly the remarkable calipers (fig. 23), which are relatively infrequent. Compasses occur in much larger numbers, and are mostly small, the two limbs inclined at an angle to one another. The long compasses are not numerous, and are small and nearly straight.

5. *Thalamoporella tubifera* Lev. (Pl. XIX, figs 26, 27; Pl. XX, fig. 1).

Thalamoporella granulata, var. *tubifera* Levinsen, 1909, MSSB, p. 189, Pl. VIa, figs 2*a—e*.
Thalamoporella rozieri, form *indica* Philipps, 1899, WZR, p. 440.

The specimen in the Cambridge Museum, from Dr WILLEY's Collection, recorded (but

not described) by Miss PHILIPPS as *T. rozieri* form *indica*, is the type of *T. granulata* var. *tubifera* Levinsen, and therefore of *T. tubifera*.

595.A. Stat. 99. North Ubian, Sulu Archipelago, 16—23 M.
206.A. Stat. 282. Timor, E., 27—54 M.

Cambridge, Mus. Zool.: —

BM Type. Deboyne Lagoon, Louisiades, New Guinea, A. WILLEY Coll., Reg. Mar. 1, 1898.

Ovicells are present in 595. A and in the type; and avicularia in all the specimens. The specimens are mostly encrusting, but 595. A was growing on a narrow Hydroid stem and had extended far beyond it so as to form a flat, bilaminar expansion tending to be Hemescharan, with some indication of the commencement of free, cylindrical branches.

Usually encrusting. Adoral areas vestigial. Zooecia large, sometimes of a rounded hexagonal form. Cryptocyst strongly granulated, with large pores. Opesiules less asymmetrical than in *T. stapifera*, both reaching the basal wall, where the insertion is incomplete distally. Avicularia large, symmetrical, the rostrum rounded distally, where it is broader than in the more proximal portion; the sister-zooecium not asymmetrical. Opesia of zooecia and gonozooecia with a distinct sinus; condyles well developed. Calcareous septum between valves of ovicell rather long. The polypide-tube is very variable and may be prolonged to meet the distal, basal or lateral walls. Compasses long and short, the larger ones very long, and both kinds usually with a very open angle. Calipers wider than long, variable in size.

The zooecia resemble those of *T. stapifera*, from which the present species is distinguished by its spicules and by its avicularia, which are widened distally, a feature not found in *T. stapifera*. The oral shelf of the zooecia of *T. tubifera* is more developed than in the allied species. The most striking difference from *T. stapifera* is shown by the calipers, which are not longer than wide, but have the more normal form, though varying in size and shape. In 206. A very long compasses are present in large numbers.

The basal insertion of the opesiules is variable. The two distal limbs are commonly approximated, and the polypide-tube frequently has a complete basal wall of its own, for a short distance proximally. The curious secondary tube (Pl. XIX, fig. 27; Pl. XX, fig. 1) described by LEVINSEN was not found in 595. A. The Louisiades material was devoid of its membranous structures, and the cavities of the zooecia had been invaded by the echinated spicules of a Monaxonid Sponge which was growing over it. A number of compact brown bodies are also present, covered by a membrane and obviously representing an advanced stage of degeneration. These appearances are in accordance with the view that the tube is due to secondary calcification, a conclusion confirmed by the fact that its walls are always much thinner than those of the polypide-tube.

Pl. XX, fig. 1 shows several conditions of this structure, which does not occur in all the zooecia. It may have the form of a cylindrical tube meeting the distal wall. The pear-shaped tube seen in the middle zooecium reaches the basal wall distally, where there is a minute pore; but it does not touch the distal wall. On the left of the figure the tube bifurcates and the two branches reach the terminal wall separating the cavity of its own zooecium from the avicularium and its sister-zooecium respectively. In another case (not drawn) the tube reaches the distal wall,

and more proximally sends off a branch to each lateral wall. LEVINSEN described the union of the tube with the zooecial wall as related to the position of the rosette-plates (see also under *T. expansa*, p. 301).

The secondary tube appears to be provided with a complete basall wall of its own. The pear-shaped structure seen in fig. 1 has also an independent frontal wall, in which I have not found any aperture leading to the body-cavity. In Pl. XIX, fig. 27 the tube has a distinct frontal wall, which, as described by LEVINSEN, has a wide orifice, partly concealed by the proximal lip of the opesia, into the body-cavity. LEVINSEN suggested that this aperture is for the passage of the tentacles. I doubt, however, whether the tube is formed before the degeneration of the polypide. It lies, moreover, close to the basal wall of the zooecium, and its frontal wall springs from the edge of the polypide-tube at a deep level. Even if the secondary tube is completely closed frontally it does not entirely occlude the passage through the polypide-tube, this passage remaining open on its frontal side.

The ovicells resemble those of *T. granulata*. They are distinctly wide in proportion to their length, and the entooecium appears to be incompletely calcified. The orifice reaches about half the length of the ovicell; and the calcareous septum between the two valves is rather long.

6. *Thalamoporella expansa* Lev. (Pl. XX, figs 2, 3, 9, 10).

Thalamoporella expansa Levinsen, 1909, MSSB, pp. 179, 190, Pl. VIb, figs 5*a—e*.

Cambridge, Mus. Zool.: —

BM Type. Torres Straits, 50, A. C. HADDON, Reg. Feb. 24, 1898.

This very distinct species has been well described by LEVINSEN, from the material now under consideration, and from specimens encrusting a *Tridacna* of unknown locality. I select the Torres Straits material as the type.

Encrusting. Adoral areas distinct, each usually bearing a rounded tubercle. Zooecia very large, with thick frontal membrane. Cryptocyst little depressed, strongly tuberculated by large pearly granules, its pores rather large. Opesia commonly filled by the operculum, with a straight proximal edge, but occasionally with a shallow sinus. Oral shelf well developed, the orifice continued beyond its usual position in the form of a large crescentic region overlapping the next zooecium. Opesiules not very asymmetrical frontally, where their opening is usually constricted; both joining the basal wall in a complete insertion and here more asymmetrical. Avicularia very short, the mandible acutely pointed and usually directed towards an orifice. Ovicells not found. Spicules long and short compasses; calipers wanting.

The zooecia (fig. 10) are conspicuously large, the adoral tubercles are prominent, and the frontal membrane is thick and brown. On the distal side of the oral shelf is the part described by LEVINSEN as an "aureola"; — a crescentic, concave hood resting on the wall of the next zooecium. The strong operculum has the form shown by LEVINSEN (fig. 5*b*). As pointed out by him, the rounded main sclerite corresponds nearly in position with the edge at the distal margin of the oral shelf, its more external portion filling the aureola.

The opesiules (fig. 10) are distant from the opesia and from one another, and their frontal orifice is constricted by a diaphragm-like outgrowth of the cryptocyst, as in some other

species of the genus. The basal insertions (fig. 3) are complete. One, with a concave distal wall, is wider than the other, and the second is usually smaller, triangular or oval in shape. The scars of the occlusor muscles (*occ.*) are visible, with unusual distinctness, as oval areas on the distal sides of the insertions of the opesiules.

Three avicularia (fig. 2) were found, all in the same position relatively to a zooecium. The rostrum is almost reversed in direction, as it points transversely and somewhat proximally towards an orifice. It forms an equilateral triangle, the mandible (of the same shape) having strong basal and main sclerites, the latter not far from the sides. LEVINSEN (fig. 5*d*) represents the mandible as rounded distally, but I find it to be acute and even acuminate.

The zooecia were dead, and in some of them a tube, of much smaller diameter than the zooecium and apparently with calcareous walls, runs through the body-cavity. LEVINSEN described this tube as sending off branches to the rosette-plates. He regarded it, no doubt correctly, as being of the same nature as the secondary tube of *T. tubifera*, and added "Most likely we have here a peculiar form of regeneration". I have found the branches ending in rosette-plates, and in cases where the plates are not visible corresponding tubes meet on opposite sides of a partition-wall. The compact brown bodies and the spicules lie outside the tube, which can hardly be formed by a shrinkage of the cellular body-wall. It is probably, as in *T. tubifera*, a case of degeneration rather than of regeneration; and it may be suggested that it is formed as a calcareous wall round the funicular tissue passing to the rosette-plates, before the final death of the zooecium.

The spicules (fig. 9) consist entirely of compasses, some of which are very long and others quite small, nearly straight or more or less angulated.

7. *Thalamoporella hamata* n. sp. (Pl. XX, figs 17—20).

67. I. Stat. 99. North Ubian, Sulu Archipelago, 16—23 M.
Type. 131. O. Stat. 164. W. of. N. end of New Guinea, 32 M.

Cambridge, Mus. Zool.: —

Torres Straits, 167, A. C. HADDON, Reg. Feb. 24, 1898.

Encrusting. Adoral areas distinct, each bearing a tubercle. Opesia with a straight proximal margin, almost completely filled by the operculum. Cryptocyst granular, with small pores. Oral shelf not developed, the distal wall of the orifice vertical. Opesiules at some distance from the orifice, not very asymmetrical frontally; both commonly reaching the basal wall, but variable in their insertion. Avicularia with an extremely long, acuminate mandible, hooked distally; the rostrum straight, oblique and of corresponding form. Ovicells not found. Operculum with a complete basal sclerite, the main sclerite marginal. Spicules, long compasses and calipers of variable form.

The specimens here described have some resemblance to *Steganoporella rozieri*, form *falcifera* Hincks (1880, AMNH, 5, VI, p. 380, Pl. XVI, fig. 2), from Australia. HINCKS' figure shows an avicularium of similar acuminate form, but the rostrum has a marked lateral curvature. The opesia is elongate, with a well marked sinus and the opesiules are close to it. LEVINSEN (1909, MSSB, p. 179, 186, Pl. VIb, figs 6*a—e*) regarded *T. falcifera* as a distinct species, and

he showed avicularia agreeing with HINCKS' figure. He described the basal sclerite of the operculum as incomplete and he found no calipers. It is thus clear that *T. hamata* is distinct from LEVINSEN's species and presumably from HINCKS' form *falcifera*.

The present species resembles *T. expansa* in the reduction of the sinus of the opesia. At first sight this part seems to be absent, but the basal sclerite of the operculum (fig. 18) is slightly concave, thus leaving a very narrow interval between itself and the straight proximal wall of the opesia. The adoral areas are well developed, and bear tubercles which are laterally compressed and lie close to the orifice; the adoral cavities being often seen through the thin calcareous roofs of these parts. The opesiules usually have the frontal opening constricted by a calcareous diaphragm, and their basal insertions are conspicuously asymmetrical. One, both or neither reach the basal wall, where their insertion is very variable (fig. 19). The larger opesiule often expands greatly before reaching the base. When the insertion-line is on the lateral wall but not on the distal wall it is complete distally, on both sides. In other cases it is completed on the lateral wall at one end and on the distal wall at the other. The insertion of the smaller opesiule into the basal wall may be reduced to a mere point, close to the base of the lateral wall; or it may end in the lateral wall and thus not reach the base.

The avicularium (fig. 17) has a very narrow rostrum, which diverges from the sister-zooecium, so that the proximal end of the next zooecium of its own row is intercalated between it and that zooecium. The lateral walls of the rostrum are raised and converge distally, the floor of this part reaching more than half the length of the rostrum. Its proximal cryptocyst is of moderate size. The mandible (fig. 18) is laterally compressed in its narrow part, which has a sharp knife-like edge running longitudinally along its basal surface. At its end the mandible is strongly hooked (hence the trivial name), in the vertical direction. The operculum (fig. 18) is strong, with a complete basal sclerite, slightly curved; and a main sclerite, near its margin. A preparation of 67.I demonstrates the insertion of the tendons of the occlusor muscles into the two small knobs shown in the figure on the main sclerite.

The spicules (fig. 20) are long compasses, nearly straight or somewhat angulated, occasionally with one arm irregularly bent; and calipers, some wide and open and others narrower, with a more pronounced curve. I have not found small compasses.

8. *Thalamoporella gothica* (Busk).

Membranipora gothica (Rylands, MS.) Busk, 1856, QJMS, IV, p. 176, Pl. VII, figs 5—7. Mazatlan (Mexico, Pacific side); — 1857, CMM, p. 2.
Thalamoporella rozieri (pars) Levinsen, 1909, MSSB, pp. 178, 181 (nec Aud.).
Thalamoporella rozieri, var. *gothica* Levinsen, op. cit., p. 184.
Steganoporella rozieri, form *gothica* Hincks, 1880, AMNH, 5, VI, pp. 379, 380, Pl. XVI, fig. 3. California.

The British Museum possesses several of BUSK's original specimens, and I select as the type the slide 99. 7. 1. 1511, from Mazatlan. *Vincularia gothica* Busk (1884, Chall. p. 72), which was referred to *Thalamoporella* by WATERS (1888, Chall., p. 13) is a very different species and was placed by LEVINSEN (1909, p. 164) in his genus *Hemiseptella*, of which the genotype is *Vincularia labiata* Busk (1884, p. 73) by the selection of CANU and BASSLER (1923, USNMB, 125, p. 69).

Encrusting or erect. Adoral areas with or without tubercles, which may be very large

(thin and almost spine-like in the type). Opesia with a deep sinus, oral shelf well developed. Opesiules variable, sometimes very asymmetrical in frontal view, the smaller one shallow; the basal insertion variable. One usually meets the basal surface, its insertion closed or open. Avicularia with acutely pointed mandibles, the distal end of which is decurved and hook-like. Operculum typically with a complete basal sclerite, sometimes incomplete in the young state. Ovicell unknown in most of the varieties, but present in 99. 7. 1. 1512, part of BUSK's type-material from Mazatlan. Spicules, short compasses, which may be accompanied by long ones; and calipers, sometimes differentiated into a larger and a smaller kind, which in other cases intergrade in size.

LEVINSEN identified this species, I think wrongly (see p. 290) with *T. rozieri* (Aud.). He regarded it as a widely distributed form exhibiting much variation; distinguishing five varieties, under the names *labiata*, *sparsipunctata*, *prominens*, *gothica* and *californica*. Much of his work on this (and other) species was done with material, now in my hands, from the Cambridge Collection (BM). I think that var. *californica*, the only one in which he found ovicells, is probably a distinct species. Of the others I cannot satisfy myself that *sparsipunctata* is distinct from *prominens*.

8a. *Thalamoporella gothica* (Busk), var. *indica* Hincks (Pl. XX, figs 4—8).

Steganoporella rozieri, var. *indica* Hincks, 1880, AMNH, 5, VI, pp. 379, 380, Pl. XVI, figs 1, 1*a*. India.

(?) *Thalamoporella rozieri*, form *indica* Thornely, 1905, PGM, p. 112 (no description). Ceylon.

Thalamoporella rosieri, var. *falcifera* Maplestone, 1905, PRSV, XVII (N. S.), p. 386, Pl. XXVIII, fig. 1 (with ovicells and avicularium). Lord Howe Id.

Thalamoporella rozieri, var. *labiata* Levinsen, 1909, MSSB, p. 182, Pl. VI, fig. 6*a*—*k*. India, Singapore, Formosa Channel.

(?) *Thalamoporella rozieri* Thornely, 1912, PIOS, p. 145. Various localities in the Indian Ocean.

Thalamoporella rozieri Marcus, 1921, IPBS, p. 10. Gaspar Strait.

291. B.
371. E. } Stat. 273. Jedan, Aru Is, 13 M. (291. B is bilaminar).

Cambridge, Mus. Zool.: —

BM Torres Straits, 168, A. C. HADDON, Reg. Feb. 24, 1898.
BM Singapore, 52, 7—10 fath., R. HANITSCH, Reg. June 19, 1900 (Hemescharan).
BM India, Miss E. C. JELLY, Reg. Oct. 24, 1898.
BM Paumben (between India and Ceylon) and Formosa Channel, presented by LEVINSEN, who also determined those from Torres Straits and Singapore (as *T. rozieri*, var. *labiata*).

The habit is often encrusting. Ovicells are wanting in all the specimens here considered, but they were described by HINCKS and by MAPLESTONE in a form which I refer provisionally to this variety.

The varietal name *labiata* Lev. should apparently be suppressed in favour of HINCKS' earlier name *indica*. The structure alluded to by LEVINSEN is a calcareous lower lip, which projects into the sinus of the opesia from its proximal side, and is specially well marked in his specimens from Formosa and India. The characters of the specimen from Formosa presented by LEVINSEN to the Cambridge Museum are as follows. — The zooecia are large, the adoral areas distinct, sometimes with tubercles, and the sinus of the opesia deep. The cryptocyst is much depressed at the level of the opesiules and the median process ascends steeply towards

the opesia, its direction being continued by the lower lip, which is thus nearly vertical. The lower lip nearly fills the sinus, leaving a very narrow slit between its free edge and the base of the operculum, which is raised far above the level of the depressed part of the cryptocyst. The avicularia are prominent distally, and their mandibles are acute, with decurved points. The larger opesiule alone reaches the base, frequently expanding considerably before it completes its closed, loop-like insertion. Two kinds of calipers are present, respectively large and small, the larger ones being much the thicker. The compasses are very small, nearly straight or with the two halves meeting at a very obtuse angle.

The above features, which are well illustrated by LEVINSEN's figures, are also found in the Siboga specimens, except that the lower lip is smaller or completely wanting. Fig. 4 shows the deep sinus of the opesia and the marked asymmetry of the opesiules, of which the smaller is shallow and is close to the lateral wall. The adoral tubercles are variable (fig. 4, 5). The basal view (fig. 8) shows the usual mode of insertion of the larger opesiule, and further demonstrates the fact that this belongs to the side of the zooecium which contains the alimentary canal. The opesiule commonly dilates considerably just before reaching the basal wall, as in the Formosa slide. The size of the insertion varies much, but it is constantly closed. In the specimen from India many of the opesiules have simple, delicate, calcareous spines projecting into them from various parts of their walls, near the frontal surface.

The adoral cavities are large and conspicuous, particularly in young zooecia and avicularia (fig. 7), those of the avicularia being much the larger. The mandible (fig. 5) is very acutely pointed, its free tip being bent down in a hook-like manner. The actual tip is not easily seen in a frontal view, since it passes in a basal direction round the free end of the rostrum. A pointed mandible of this form, though with its hooked termination not always so sharply marked as in fig. 5, is specially characteristic of this species and of its varieties. The halves of the main sclerite approach one another distally, where they may be parallel for a short distance.

The two kinds of calipers and the small compasses, which are not common, are shown in fig. 6. In the Paumben specimen and in 371. E (Siboga) some slight evidence has been obtained with regard to the mode of origin of the larger spicules, but development seems to take place so rapidly that the smaller spicules are complete as soon as they are distinguishable. The growing margin of the colony contains a considerable mass of more or less solid tissue, in which are embedded very numerous spicules. The large calipers calcify from the middle outwards, the recurved tips being the parts last formed.

8b. *Thalamoporella gothica* Busk, var. *prominens* Lev.

(?) *Thalamoporella rozieri* Robertson, 1908, ICNA, p. 277, Pl. XVII, figs 27—29; Pl. XVIII, fig. 30. California. (Or typical *T. gothica*?)
Thalamoporella rozieri, var. *prominens* Levinsen, 1909, MSSB, p. 183, Pl. VIb, figs 1*a—f*.
Thalamoporella rozieri, var. *sparsipunctata* Levinsen, 1909, p. 183, Pl. VIb, figs 3*a*, *b*.

254. B. Stat. 315. Paternoster Is, N. of Sumbawa, 0—36 M.

Cambridge, Mus. Zool.: —

BM Torres Straits, 74, 98 (type of var. *prominens* Lev.), 149, 209, A. C. HADDON, Reg. Feb. 24, 1898.
BM Port Denison, Queensland (type of var. *sparsipunctata* Lev.), from Collection described by W. A. HASWELL, Australian Museum, Reg. June 2, 1902.

Holborn Id, Queensland, Miss E. C. JELLY, Reg. May 24, 1895.
"Probably California", HINCKS' Collection, Reg. May 13, 1899 (Cellariiform).

The Torres Straits slides 74, 98 and 149 were determined by LEVINSEN as var. *prominens*, and I select 98 as the type-specimen. Var. *sparsipunctata* was also based on the Cambridge material here considered. Both varieties have typically an erect, Cellariiform habit, and I cannot satisfy myself that they are distinct. In addition to the zoarial character, the following points appear to be distinctive. — The zooecia are larger than in var. *indica*, the basal insertions of the opesiules are more variable, the mandibles are less abruptly bent at their tips, long compasses are usually present, and the calipers are less distinctly differentiated into two sizes.

Although this variety has been found encrusting, this may perhaps be the base of a colony able to produce erect branches. The stems of other specimens are Cellariiform, but are not of uniform diameter (see LEVINSEN, Pl. VI b, fig. 1 *a*), and they differ from those of *T. novae-hollandiae* in being jointed. The joints are formed in the usual manner by the absorption of annuli of the calcareous walls of zooecia. While in most other similarly constituted zoaria the zone of absorption is a narrow ring, in this variety it is much more extensive, often occurring for the whole length of a zooecium; and the flexible parts of the stems are thus unusually long. Immediately above a joint the stem remains narrow and nearly cylindrical, for some distance, then gradually widening so as to form a palmate, flattened expansion, from which a bifurcation originates.

The avicularia vary greatly in size, being specially large and prominent in Torres Straits 98. The opesiules vary much in their basal insertion. LEVINSEN described one insertion, incomplete distally, in var. *prominens*; and, with some hesitation, probably two, closed, in var. *sparsipunctata*. With regard to the latter I am not satisfied that he was right. In a Cellariiform species the zooecia are wedge-shaped, with a wide frontal wall and with lateral walls converging towards the axis of the internode, in some cases meeting at the axis so that no basal wall exists. From an examination of the type-specimen I conclude that the characteristic arrangement is for the larger opesia alone to meet the basal wall in a closed insertion, usually expanding greatly before doing so, and in one case extending completely across the zooecium to the immediate neighbourhood of the opposite lateral wall. In other zooecia, even if a basal wall is present, neither opesiule reaches it. The Siboga 254. B is referred to this variety doubtfully. It is an encrusting fragment, with typical but rather small avicularia; but the opesiules, which are more alike than usual, both reach the basal wall in an insertion which is not closed distally.

In typical specimens of var. *prominens* (Torres Straits 149) I find the arrangement to be variable. Most commonly one opesiule alone meets the basal wall, with a closed, often expanded insertion, which is less often open distally. In one case both have closed insertions on the basal wall, the smaller one only just touching it. Both may meet the base, with open insertions, and not uncommonly neither touches it.

Although the calipers vary in size, the larger ones are less thick than in the other variety, and calipers of intermediate size connect them with the small kind. Another noteworthy fact is the occurrence of large, nearly straight compasses.

Remarkable Cellariiform specimens with long joints, from California (HINCKS Coll., British Museum, 99. 5. 1. 752, 754 and Cambridge, as above) seem to belong to this variety, or perhaps

to the typical form of *T. gothica*. The cylindrical internodes, up to 8 mm. long, recall in their regularity those of *Microporina borealis* [1]). Their bases and sometimes their distal ends are narrower than the rest of the internode, though in other cases becoming rather broader and somewhat flattened before the bifurcation. The avicularia are typical and the adoral tubercles strongly developed. The hooked distal end of the mandible passes into the rest of the organ in a strong curve and not with an abrupt bend, as in the other variety. Large and small calipers occur sparingly, but I have found no compasses.

The adoral tubercles of Torres Straits 74, an encrusting specimen, are strong, cylindrical processes of considerable length, mostly truncate and closed by a membrane at their ends, indicating imperfect calcification; but are occasionally completed by a rounded summit. The avicularia are large and extremely prominent. In specimens from other localities the tubercles may be small or absent.

The form described by Miss ROBERTSON as *T. rozieri*, from California, is encrusting or erect, a specially fine colony of the erect habit having been 20 cm. long. The branches are divided into internodes by joints consisting of zooecia without calcareous matter in their walls. The avicularia have mandibles hooked at the tips; and ovicells of the usual *Thalamoporella* type are described and figured. The orifice of the ovicell is represented in the figure as occupying considerably less than half the length of the ovicell itself.

Fam 4. MICROPORIDAE.

Microporidae Gray, 1848, BMRA, pp. 115, 147.
Microporidae (pars) Smitt, 1873, KVAH, XI, N^0 4, p. 13.
Microporidae Hincks, 1880, BMP, p. 172.
Microporidae Levinsen, 1909, MSSB, p. 161.

This Family is characterised by the cryptocyst, filling the entire area as far as the margin of the orifice, from which the opesia is no longer distinguishable, by the presence of closed opesiules, by the semicircular orifice and operculum and by the raised margins of the zooecia outside the area. Avicularia and ovicells occur in certain species, but are not universally present.

Although not always described, opesiules probably occur in all cases. I have previously shown (1902, QJMS, XLVI, p. 316), in confirmation of JULLIEN's earlier results, that they are an essential part of the mechanism of the zooecium, in transmitting the tendons of the depressor muscles by which the extrusion of the polypide is effected. If they transmit no more than a fine tendon they are capable of being reduced to a very small size without affecting their efficiency, and they may thus be overlooked or not distinguished from the ordinary surface-pores.

MARCUS (1921, BJFI, p. 100) has recently pointed out the great difficulty that exists in characterising the species of this Family, owing to the variability of such structures as the opercula, the opesiules and the adoral tubercles. With much that he says I agree, but I venture to think that further study, particularly of the opesiules, will remove some existing difficulties.

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1) *Salicornaria borealis* Busk (1855, QJMS, III, p. 254, Pl. I, figs 1—3), placed by LEVINSEN 1909, MSSB, p. 162) in *Microporina*, was regarded by SMITT (1867, KVAF, XXIV, pp. 361, 362) as synonymous with *Cellularia articulata* Fabricius (1821, KDVSA, I, p. 27).

JULLIEN (1888, CH, pp. 78, 79) proposed a number of new genera of Microporoid forms. These have been adversely criticised by WATERS and others, but I think they deserve consideration. The Siboga representation of the Family is very limited, and I must confine myself to JULLIEN's genera *Peneclausa* and *Calpensia*, with *Micropora* Gray and *Monoporella* Hincks.

1. **Micropora** Gray [1]) (not represented in the Siboga Collection).

Micropora Gray, 1848, BMRA, pp. 115, 147.
Micropora Hincks, 1877, AMNH, 4, XX, p. 529; — 1880, BMP, p. 173.
Micropora Levinsen, 1909, MSSB, p. 162.
Peneclausa Jullien, 1888, CH, p. 78.
Monotypical. Genotype, *Flustra coriacea* Johnston, 1847, HBZ, p. 348 (see below).

The opesiules are mere perforations in the cryptocyst. (Ovicells small, entozooecial but prominent, LEVINSEN). Orifice without oral spines, or at least without distal spines. A small avicularium may occur on the proximal surface of a zooecium.

Micropora was introduced by GRAY for a single species, *M. coriacea*, which must accordingly be the genotype. His first two synonyms are *Flustra coriacea* Esper, Pflanz. *Flustra* t. 7, fig. 2 and Johnst. Hist. Brit. Zooph. ed. 2, p. 349, t. 56, fig. 8. SMITT (1873, KVAH, XI, N° 4, p. 13 n. 5) pointed out, I think correctly, that ESPER's species is probably identical with *Membranipora bifoveolata* Heller (1867, VZBGW, XVII, p. 95), a species generally identified with *Micropora impressa* auctt. The material examined by GRAY, on which his definition (p. 147) was based, consisted of JOHNSTON's specimens from Sana Island [2]). These are in the British Museum (47. 9. 18. 129, 146) and are definitely referable to *Micropora coriacea* as usually understood. It is difficult to understand why BUSK expressed the opinion that *F. coriacea* Johnst. is a synonym of his own *Membranipora hexagona* (1856, QJMS, IV, p. 308).

ESPER's name appears on *Flustra* Pl. VII (figs 1, 2) of Theil II of the "Fortsetzungen" of the "Pflanzenthiere". No corresponding text seems to have been published at the time, and (in the British Museum copy) the Plates follow Part 10 (1806), which ends with p. 48. LAMARCK (1816, ASV, p. 168) cites ESPER's figures, under *Discopora coriacea*, and the Plate in question thus appears to have been published between 1806 and 1816. Theil III of the "Pflanzenthiere" was completed, after ESPER's death, by HAMMER, who described *Discopora coriacea*, with a reference to ESPER's Plate, on p. 322 (1830). For the dates of publication see WOODWARD, 1904, CBBM, II, p. 542.

On p. 145 of Theil I (1796) of the "Fortsetzungen" of the "Pflanzenthiere" ESPER had already described *Cellepora nobilis*, of which *Eschara impressa* Moll (1803, "Eschara", p. 51) is a synonym. This conclusion has already been accepted by PERGENS (1887, AHMW, II, p. 17) and, I think, with reason. It thus follows that *Flustra coriacea* Esper (1806—1816) is a synonym of *Cellepora nobilis* Esper (1796), and that it was thus invalid. In view of the great convenience of preserving *coriacea* in its universally accepted sense, I propose that the Rules be neglected and that JOHNSTON's name be considered valid, even though technically pre-occupied.

1) Nec *Micropora* Eichwald, Bull. Soc. Imp. Nat. Moscou, 1855, XXVIII, N° 4, p. 457.
2) Sana or Sanda Id, Clyde area, Scotland (see HYNDMAN, 1842, AMNH, X, p. 19).

The genotype of *Peneclausa* selected by JULLIEN was given as *Flustra coriacea* Esper, but his definition "l'opésiule est représentée par un très petit pore" shows that the form he had in mind was *Micropora coriacea* (Johnst.).

2. Calpensia Jull.

Calpensia Jullien, 1888, CH, p. 78.
Calpensia Canu, 1900, BSGF, 3, XXVIII, p. 434.
Calpensia Levinsen, 1909, MSSB, p. 165.
Calpensia Canu and Bassler, 1923, USNMB, 125, p. 82.
Genotype, indicated by JULLIEN, *Membranipora calpensis* Busk (1854, BMC, p. 60) (= *Cellepora nobilis* Esper, 1796; see above).

Adoral tubercles present or wanting. Opesiules tubular, reaching the lateral or basal wall, as in *Thalamoporella*. Orifice without spines. Characters of ovicells [1]) (if present) unknown. Vicarious avicularia, with acute rostrum and mandible, may occur.

Under *Micropora nobilis*, Pergens (1887, AHMW, II, p. 17) gave a very lengthy synonymy of the genotype, but CANU and BASSLER (1919, CIW, 291, p. 84) summarily rejected the greater part of this list and those of other authors, introducing at the same time a new Family, Calpensiidae. Among the synonyms which they accept are *Membranipora calpensis* Busk, *Eschara impressa* Moll and *E. nobilis* Michelin. As MICHELIN (1840—1847, IZ, p. 329) took the trivial name from ESPER and obviously described the same species, CANU and BASSLER appear to use the generic name in the sense here accepted.

LEVINSEN defined *Calpensia* as having opesiules reaching the lateral walls, a porous cryptocyst, a row of septula on the terminal wall and a single lateral [2]) rosette-plate; while possessing neither avicularia nor ovicells [3]). The terminal communication-pores observed by me in *C. reversa* do not seem to conform with LEVINSEN's statement, and his diagnosis must be amended by the qualification that the opesiules may join the basal wall.

1. *Calpensia pulchra* n. sp. (Pl. XX, figs 11, 12).

Micropora sp. Harmer, 1902, QJMS, XLVI, pp. 266, 316, Pl. XVIII, figs 57, 58; Pl. XVII, fig. 51.

Cambridge, Mus. Zool.: —

BM Torres Straits, 169 (type), 212, A. C. HADDON, Reg. Feb. 24, 1898.

Encrusting. Zooecia in distinct longitudinal rows, not narrower proximally. Orifice semi-circular, without oral spines or adoral tubercles. Cryptocyst tubercular, porous, the opesiules moderately large, their frontal openings contracted, prolonged as calcareous tubes to the basal or lateral walls. Their basal insertion is typically sub-triangular, at least on one side, its inner end prolonged into a beak-like process, concave distally, where it lodges the origin of the occlusor muscle of its side. Ovicells and avicularia not found.

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1) HELLER (1867, VZBGW, XVII, p. 95) described ovicells in *Membranipora bifoveolata*, and his account of the multilaminar, hollow colonies shows that this species was synonymous with *Calpensia nobilis*.

2) LEVINSEN actually says "distal half of each distal wall", but the second "distal" was obviously a lapsus calami for "lateral". I describe vicarious avicularia in *C. reversa*.

3) See note 1.

The trivial name is suggested in reference to the beauty of the material as demonstrating the arrangement of the opesiules and related structures.

The zooecia, arranged in definite longitudinal rows, are broad, usually not becoming narrower at their proximal ends as is usual in *Micropora*. The frontal surface is typically Microporoid, the flat cryptocyst being raised where it passes into the wall of the orifice, its proximal part as far as the opesiules porous, and its frontal edge thickened. The operculum (fig. 12) is not calcareous, and a thin sclerite passes in an even curve about half way between the proximal and distal borders, rather nearer the latter The opesiules are relatively large and their frontal openings are constricted by an iris-like calcareous film, which commonly projects frontally as a low cone, perforated at its apex. On the basal side of this the opesiule dilates and passes typically to the basal wall, into which it is inserted as shown in fig. 12. Both opesiules usually reach the basal wall, but sometimes one only, the other being inserted into the lateral wall, into which both opesiules may pass, thus agreeing with part of LEVINSEN's diagnosis of *Calpensia*. Although the retracted tentacles commonly slope towards one of the proximal corners of the zooecium, they may lie in the middle line. In either case the width of the zooecium is sufficient to allow free action to the depressors, and although there is a certain amount of asymmetry in the opesiules this occurs in a less degree than in *Thalamoporella*.

C. pulchra has a considerable general resemblance to *C. nobilis*, but this common Mediterranean species has a very different habit, since it is found in large multilaminar colonies, several inches in length, often forming wide hollow cylinders by the disappearance of the substratum on which they have grown.

2. *Calpensia reversa* n. sp. (Pl. XX, figs 13—16).

Thalamoporella rozieri, form *falcifera* Thornely, 1905, PGM, p. 112. Ceylon.

Cambridge, Mus. Zool.: —

BM Ceylon, Miss L. R. THORNELY, Reg. Apr. 25, 1906, 23.

Encrusting, covered by a thick, brown frontal membrane. Adoral areas distinct, each bearing a large, rounded tubercle. Cryptocyst depressed centrally, porous as far as the opesiules; laterally much thickened. Opesiules large, their frontal openings irregularly invaded by the thickened lateral cryptocyst, both joining the basal wall. Avicularia rare, vicarious (reaching the basal surface), narrow, forming a nearly square area at the commencement of a bifurcation of a longitudinal row; the rostrum narrow, acute, directed obliquely proximally, the apex nearly reaching the orifice of the preceding zooecium. Operculum with two small distal teeth and a curved sclerite at some distance from the margin. Ovicells not found.

The dry specimen on which my description is based was sent by Miss THORNELY to the Cambridge Museum as part of the material recorded, but not described, by her as *Thalamoporella rozieri*, form *falcifera*. I have found no trace of spicules, and the general characters seem to justify the reference of the species to *Calpensia*.

The basal insertions of the opesiules are shown in fig. 14, which also shows that the distal communication-pores are probably not a row of septula, as described by LEVINSEN for the genus, but are restricted to a short region, distinguished by its thinness from the other parts of

the wall. I cannot decide, however, whether the communications are uniporous or multiporous. The species is of interest in possessing vicarious avicularia, the proximal direction of the rostrum being referred to in the trivial name. The adoral tubercles are conspicuous, as in species of *Thalamoporella*. The operculum (fig. 15) is well chitinised throughout, but has no definite basal sclerite. From its straight proximal margin start the two ends of a curved main sclerite, which is at some distance from the margin. On each of the outer sides is a marginal tubercle, which is no doubt for the insertion of the occlusor muscle. Distally to these tubercles are a pair of minute, acute, distal teeth.

3. **Monoporella** Hincks.

Haploporella Hincks, July, 1881, AMNH, 5, VIII, p. 10.
Monoporella Hincks, Aug., 1881, *t. cit.*, p. 135 (Explanation of Pl. I), to replace *Haploporella* [1]), pre-occupied; — 1881, PLPSL, XXXV, p. 260.
Genotype, selected by NORMAN (1903, AMNH, 7, XII, p. 115), *Haploporella nodulifera* Hincks (1881).

Opesiules as in *Micropora*. Ovicell large, obviously covered by the frontal membrane of the succeeding zooecium and (in the genotype) with large longitudinal slits in the distal part of the entooecium. Orifice with distal spines, the series sometimes continued as numerous marginal spines round the entire area [2]). Avicularia unknown.

1. *Monoporella nodulifera* (Hincks). (Pl. XX, figs 21—23).

Haploporella nodulifera Hincks, 1881, AMNH, 5, VIII, p. 11. Bass Straits.
Monoporella nodulifera Hincks, *t. cit.*, p. 135, Pl. I, fig. 4; — 1881, PLPSL, XXXV, p. 260.

108. U. Stat. 144. S. of Halmaheira (Djilolo), 45 M.

Cambridge, Mus. Zool.: —

BM Torres Straits, 48, A. C. HADDON, Reg. Feb. 24, 1898.

British Museum: —

China Sea, Macclesfield Bank, 35 fath., 89. 8. 21. 129.

Encrusting. Zooecia large, separated by furrows, covered by a thick brown frontal membrane provided with a pair of circular sclerites for the insertion of the depressor muscles. Orifice somewhat raised, the thick lateral walls ascending to it from the distal end of the zooecium; commonly with a pronounced tubercle on each side; more or less semicircular, its proximal border straight; two to eight thin, black spines on its distal side. Operculum jet-black, thick, its outer surface covered by numerous shallow pits. Cryptocyst deepest near the proximal side of the orifice, reticulato-punctate, with a pair of minute opesiules at the deepest part. Ovicells very large, their frontal surface only slightly convex.

In his original account of this species HINCKS stated that he had found only a single

1) *Haploporella* Gümbel, 1871 (ABAW, XI, 1, p. 256), for calcareous organisms described as Foraminifera. Most of his species are calcareous Algae (see SHERBORN, 1893, SMC, XXXVII, N° 856, p. 155), but *H. fasciculata* has been regarded as an Echinoderm spine. If this is correct, *Haploporella* Gümbel may be considered to have been used in Zoology, and therefore to invalidate *Haploporella* Hincks. It is desirable to find a reason for not reviving this name, after its short life of one month; — a procedure which would involve the rejection of the accepted designation *Monoporella*.

2) Thus described in *M. tahitiensis* Waters, 1925, AMNH, 9, XV, p. 342, Pl. XXII, figs 1, 2.

colony, on shell. Among his specimens in the British Museum is a slide labelled *Monoporella nodulifera*, Australia (99. 5. 1. 742); but it does not correspond with fig. 4 of this author. There can be little doubt, however, that it is correctly determined; and the study of it and of the new material shows that HINCKS was mistaken in placing his genus in the Microporellidae.

M. nodulifera is in fact typically Microporidan, as is shown by its depressed cryptocyst and by its opesiules. These are but little larger than the ordinary pores, but they are recognisable in all the specimens examined.

In 108. U the zooecia are covered by a thick frontal membrane, in which a small circular sclerite is a conspicuous feature, in the neighbourhood of each opesiule (Fig. 21). In the dry preparation the frontal membrane is drawn in, as if by the contraction of a depressor, while the proof of the real nature of the sclerite is completed by the corresponding perforation in the cryptocyst (fig. 22) and still more directly by a Canada balsam slide, which demonstrates the existence of the depressors and their tendinous insertions into the sclerites. At the bottom of the grooves separating the zooecia is a sharply marked "chitinous line", representing the junction of the frontal membrane with the chitinous edges of the vertical walls.

The Siboga and Torres Straits specimens are characterised by the jet-black colour of their opercula and spines, the latter being very slender (frequently broken off) and two, three or four in number. There is no evidence that HINCKS saw the opercula, as he would certainly have commented on their unusual colour if he had observed them. His statement that the spines have black bases (whereas they are completely black) leads me to think that his figure was a reconstruction and that his British Museum slide is really the type-specimen. The operculum, which is probably calcareous (as occasionally in *Micropora*), is further characterised by its peculiar outer surface, which is covered by circular pits (fig. 23), resembling those on a thimble. It articulates with two inconspicuous condyles at the proximal lip of the orifice (fig. 22), which is occasionally buttressed proximally by a slight median ridge of the thick, porous cryptocyst.

108. U has one complete ovicell (fig. 21), which is large and broader than the zooecium. Its frontal surface is rather flat, and its entooecium extends over most of the succeeding zooecium, of which the thick frontal membrane represents the ectooecium. I have not thought it advisable to remove the membrane, but on moistening it with water, indications of four deep longitudinal grooves were seen on the distal half of the entooecium. These are more distinctly visible in an ovicell in Torres Straits 48. The ovicell is closed by the operculum, which resembles the ordinary opercula in all respects. At its sides the lateral walls are prolonged into distinct tubercles.

A specimen in the Cambridge Collection (Reg. Sept. 23, 1896), found among rooting spicules of *Euplectella marshalli* from Japan, is at least closely allied to the present species, but is probably distinct. It has the same large, robust zooecia and black opercula, but spines seem to be wanting, the opercula are not pitted and are rather more than a semicircle. The parts at the sides of the ovicell do not bear tubercles, and the lateral projections of the gonozooecium which overlap the orifice have a long, transverse suture with the entooecium, each having in at least one case a large, uncalcified fenestra on the proximal side of the suture. The ovicells are similar those of *M. nodulifera*, and the four distal grooves above mentioned are wide slits, of a length about equal to the width of the opercula. The opesiules agree with those of the Siboga and other specimens.

I have noted above a specimen from the Macclesfield Bank which I refer to *M. nodulifera*. Another specimen (89. 8. 21. 84), from 36 fath. in the same locality, resembles the Japanese specimen in having smooth opercula. The spines are 4—6, black and narrow at their base, then becoming much wider, and having here a very white colour. Conspicuous black depressor sclerites are present, but there are no ovicells in either Macclesfield Bank specimen.

M. nodulifera has a considerable resemblance, which is purely superficial, to *Monoporella spinifera*, which, with the allied *M. polymorpha*, was described by Miss Philipps (1899, WZR, pp. 445, 444, 440) from Lifu, Loyalty Is. These two species should be referred to *Macropora* MacGillivray (1895, TRSV, IV, p. 54), principally on the evidence given by Levinsen (1909, MSSB, p. 162). This genus was instituted for two species, of which *M. centralis* was selected as the genotype by Canu and Bassler (1920, USNMB, 106, p. 277). The "aperture of peculiar structure" figured by Levinsen (Pl. VII, fig. 1 *b*) resembles a form of orifice described and figured, in *M. polymorpha*, by Miss Philipps (Pl. XLII, figs 3, 3 *a*).

I am not satisfied that *Macropora* is correctly referred by MacGillivray and Levinsen to the Microporidae, as there is no evidence of the occurrence of opesiules; or that Canu and Bassler had sufficient reason for placing it in the Coscinopleuridae. It is not even certain that it belongs to the Anasca, and the same may be said of other supposed Microporidae, the systematic position of which requires further study.

Fam. 5. Selenariidae.

Selenariadae (pars) Busk, 1854, BMC, p. 97.
Selenarinae Gregory, 1893, TZS, XIII, p. 224.

Under the Lunulariidae (p. 262) I have referred to Gregory's division of the Selenariadae of Busk into two groups, one of which, the Selenarinae, was characterised by having a Microporine frontal wall and orifice. I have pointed out, in the same place, that this distinction does not hold good for all species of *Selenaria*, in which the parts indicated may be Membraniporine.

This difficulty is possibly removed by the evidence given below that some reduction has occurred in the calcareous frontal wall of *Selenaria hexagonalis*, which may accordingly have been derived from an ancestor with a Microporine frontal wall. I think it best to accept Gregory's conclusion provisionally, particularly in view of the fact that the Siboga Collection includes only one indeterminable colony referable to *Selenaria*.

Selenaria Busk.

Selenaria Busk, 1854, BMC, pp. 97, 101.
Selenaria Levinsen, 1909, MSSB, pp. 89, 155.
Selenaria Canu and Bassler, 1923, USNMB, 125, p. 59.
Monotypical. Genotype, *S. maculata* Busk, 1854, p. 101.

Proximal cryptocyst usually produced into a median process, which may be evanescent; or well developed, giving rise to distinct, open opesiules; or uniting with the lateral walls so as to form closed opesiules. Vibracula scattered in the colony, not in radial rows, in most

cases covered by a calcareous lamina, porous or cribriform. Entozooecial ovicells are said to occur (LEVINSEN).

The special modifications of the cryptocyst and of the vibracula are well illustrated by two recent species described by MAPLESTONE [1]) and represented in the Cambridge Collection (BM) by part of the type-material. In *S. hexagonalis* the opesia is deeply depressed, owing to the steep descent of the cryptocyst, and in the functional zooecia there is no trace of the median process. In the more central zooecia, which have become occluded by a calcareous lamina, two opesiules are usually left. Occlusion commences by the formation of a median process, produced by the proximal cryptocyst, commonly meeting a smaller process formed in the middle of the distal part of the opesia. The median process has perhaps disappeared in the functional zooecia by reduction. The vibracula are covered by cribriform bars, resembling those of the zooecia of *Membraniporella*. *S. bimorphocella* has a well developed median process and a large, closed opesiule on each side of it. The median process may fail to meet the lateral wall on one side, in which case the opesiule remains open. The calcareous lamina closing the vibraculum is perforated by numerous, small pores. The vibracula and the median processes of the two species thus differ in important respects, and they need elucidation both as to their function and as to their taxonomic significance.

1. *Selenaria*, sp. incert.

448. B. Stat. 59. Samau Strait, W. Timor, 390 M. 1 dead colony.

A single, worn specimen obtained by the Siboga measures just over 5 mm. in diameter and 3 mm. in height. In its present condition the opesia is variable in form, sometimes rounded, more often longer than wide, and occasionally obscurely trifoliate. Indications of vibracula occur, but the calcareous occluding lamina is completely lost. In view of these deficiencies, a reliable determination can hardly be made.

Fam. 6. PORICELLARIIDAE nom. nov.

Diplodidymidea Reuss, 1869, SAWW, LIX, 1, p. 468.

With the characters of *Poricellaria*. Differing from the Microporidae in the delicate, erect and jointed habit, in the remarkably asymmetrical zooecia and in the unilateral, slit-like opesiule.

CANU (1907, AP, II, p. 142 = sep., p. 38) has stated that *Diplodidymia* Reuss is a synonym of *Poricellaria* D'Orb. (see HARMER, 1923, JLS, XXXV, pp. 307, 315); but he did not accept the earlier generic name, apparently because D'ORBIGNY gave no figures. If D'ORBIGNY's genus is to be recognised and to be given Family rank, as I think necessary, the name for its Family should be Poricellariidae.

Poricellaria D'Orb.

Poricellaria, D'Orbigny, 1852, ASNZ, 3, XVI, p. 338; — 1854, PFTC, p. 1106.
Diplodidymia Reuss, *l. c.*

1) MAPLESTONE, C. M., 1904, PRSV, N. S., XVI, pp. 213, 214.

Diplodidymia Canu, 1900, BSGF, 3, XXVIII, p. 418; — 1907, *l. c.*
Diplodidymia Waters, 1913, BEA, p. 490.
Diplodidymia Canu and Bassler, 1923, USNMB, 125, p. 67.
Monotypical. Genotype, *P. alata* D'Orb., 1854.

Stem jointed, giving off basal rootlets and produced into dichotomising branches composed of internodes separated by chitinous joints. Zooecia in four (two to four?) longitudinal, alternating rows, the semicircular, oblique orifices opening on the frontal surface and on the lateral edges. Cryptocyst large, reaching the orifice, which is co-extensive with the opesia, deeply depressed, mainly without pores, traversed by a single, elongate opesiule on one side. An avicularium, with acute mandible, near the proximal end of each zooecium. Ovicells unknown.

It seems open to doubt whether the descriptions of the fossils *Poricellaria alata* D'Orb. and *Diplodidymia complicata* Reuss (each the genotype of a monotypical genus) were correct in all respects, particularly with regard to the number of longitudinal rows of zooecia. Canu (1907, Pl. XIX (V), fig. 7) has figured a specimen which belonged to D'Orbigny, who described it as triserial. Both from this figure and from those of *Cellularia diplodidymioides* Meunier and Pergens (1886, BSM, p. 3, Pl. II, figs 3*a*—*c*), regarded by Canu as a synonym of *D. alata*, it appears possible that the arrangement is really quadriserial, as in the recent species described below. There seems to be no reasonable doubt that the recent form is congeneric with the fossils, for which D'Orbigny's earlier name ought to be accepted. I do not agree with Waters (1913) in regarding it as belonging to *D. complicata*. Reuss stated that in a frontal view (his fig. 6) of that species the zooecia of both median rows have the same obliquity and that the two lateral edges are quite unlike, one having all the orifices and the other having none. This does not seem to be illustrated, however, in the figures (Pl. III, figs 8, 9) he gave to explain this difference. Even if his orientation does not correspond with my own, it is hardly possible to place his figures so as to make the arrangement of the zooecia conformable with that found in the recent species.

1. *Poricellaria ratoniensis* (Waters), Pl. XVII, fig. 14; Pl. XXIII, figs 3—8; text-fig. 12).

Micropora ratoniensis Waters, 1887, AMNH, 5, XX, p. 185, Pl. IV, fig. 5. New Guinea, 7 fath.; — 1910, JLS, XXXI, p. 239.
Micropora katowensis [1]) Waters, 1891, QJGS, XLVII, p. 14 n.
Diplodidymia complicata Waters, 1913, BEA, p. 490, Pl. LXVII, figs 11—15, text-fig. 79. Zanzibar, 3 fath.
(?) *Micropora articulata* Waters, 1891, *t. cit.*, p. 14, Pl. II, figs 5, 6, Bartonian, N. Italy.

332. A. Stat. 64. Tanah Djampeah, between Flores and Celebes, 0—32 M.
40. D. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
388. B. Stat. 81. Borneo Bank, Strait of Makassar, 34 M. Fragments.
501. O. Stat. 163. Seget, N. end of New Guinea, 29 M.
299. A. Stat. 273. Jedan, Aru Is, 13 M.

Zoarium articulated, the internodes reaching a length of 6 mm. Zooecia in four longitudinal, alternating rows. Orifices semicircular, those of the two inner series near the middle line of the front of the internode, inclined obliquely inwards at an angle of 30°—60° with the main axis.

1) The name of the locality, which had been misread "Raton", is really Katow.

Those of the external rows are at the extreme outer borders of the internode, facing frontally and directed almost at right angles to the main axis. Cryptocyst deeply depressed below the lateral edges, which are much raised; a single slit-like opesiule on the inner side only. Avicularium quadrate, covering the entire frontal surface of the zooecium on the proximal side of its frontal membrane; the rostrum transverse, narrow and acuminate. The avicularia of the two median series are on the front of the branch, the freely projecting tip of the rostrum reaching the distal border of the orifice of a zooecium of an outer series. Those of the outer zooecia are on the basal side of the branch, the rostrum directed towards its middle line. On the proximal side of the tip of its rostrum each avicularium has a cup-shaped depression with a pore at its middle. Joints composed of three parallel chitinous tubes, with thick, compound walls.

Fig. 12. — *Poricellaria ratoniensis*. Zoarium (40. D[1]), natural size.

The discovery of a recent Oriental member of a genus previously known only from early Tertiary formations in Europe is due to Waters, who has given a good account of the structure, principally in his 1913 paper, where he described the embryos as developing in an internal ovisac.

P. ratoniensis (text-fig. 12) resembles *Nellia oculata* in size and general appearance. The proximal part (Pl. XVII, fig. 14) is composed of a row of long kenozooecia, cylindrical but slightly dilated at each end, with an elongate slit closed by a vestigial frontal membrane on one surface. The wall of the kenozooecium is thick, leaving an extremely narrow central lumen, from which fine pores pass to the membrane. Waters states (1913, p. 490) that the cellular contents send a branch to the surface, as in *Chlidonia*.

The stem is attached by rootlets (fig. 14) given off from the proximal ends of the lower kenozooecia, some of them running along the surface before spreading out at the base; and Waters has shown that the rootlets may give rise to new erect stems. The uppermost kenozooecium is succeeded by an internode consisting of a single zooecium with its associated avicularium; and this is followed by normal internodes.

In a frontal view of an internode (Pl. XXIII, fig. 6) all four rows of zooecia are visible, the lateral zooecia showing only their distal ends, with their orifices so oblique as to have their proximal margin almost longitudinal. The lateral walls are much elevated, especially distally, where they join the frame of the semicircular orifice. The opesiule is slit-like and in decalcified preparations is seen to transmit a strong depressor muscle. The cryptocyst is otherwise imperforate except for two minute pores, as described by Waters, at the base of the lower lip. The two median rows of zooecia are separated by a sinuous groove; a similar median groove occurring on the basal side (fig. 7), where the outer zooecia are seen foreshortened, with the opesiule on the outer side. The opesia is not visible, and the part of the cryptocyst leading to it is strongly curved laterally. If these zooecia could be rotated so as to lie on the frontal surface, the opesiules would be on their inner sides, as in the median zooecia. The avicularia of the outer rows are completely on the basal surface. In side view (fig. 8) the outer zooecia are more completely visible, the orifices being seen edgeways.

The operculum (fig. 3) is strong, with a marginal sclerite. The mandibles (fig. 4) are acicular, decurved distally. The chitinous joints between the internodes consists of three compound tubes, *en échelon*, as in species of *Scrupocellaria* (see below). The outermost part (fig. 5) is a

simple cylinder, of a yellow colour in a picronigrosin preparation, and each successive tube is rather longer than the one on its outer side. The two ends, enclosed in the calcareous parts, thus show the free edges of five or more tubes and have a deep nigrosin colour.

Waters (1887, AMNH, 5, XX, p. 185) has commented on the resemblance of *P. ratoniensis* to *Setosella folini* Jullien (1883, BSZF, VII, p. 523), a deep water form which has been recorded by Calvet (1907, BTT, p. 394) from 555 to 3700 M. off Marseilles, the south of Portugal, the Gulf of Gascony and the Canary Is. This species is perhaps referable to *Poricellaria*.

Fam. 7. Chlidoniidae.

Chlidoniadae Busk, 1884, Chall., p. 8.
Chlidoniidae Levinsen, 1902, VMNFK, p. 22; — 1909, MSSB, p. 196.

Zoarium erect or repent, in the former case jointed. Zooecia typically pyriform, commencing with an elongate, narrow, tubular portion, which may be suppressed; their distal portion expanded, one surface being more or less flat and covered by the frontal membrane. Cryptocyst either strongly developed, with a frontal depression, on the distal side of which it is prolonged into a lamina reaching the proximal margin of the operculum; or reduced to a small lip-like portion which does not extend much beyond the proximal end of the aperture. Vicarious avicularia, possessing a polypide, rarely present. Spines and ovicells wanting.

The Chlidoniidae have hitherto been treated as a Family represented by a single genus, *Chlidonia*. I have modified the diagnosis so as to include *Crepis* Jullien, the zooecial characters of which are substantially identical with those of *Chlidonia*. *Crepis decussata*, a most remarkable new species described below, is of great interest in possessing avicularia provided with a polypide. This fact appears to indicate that in the other members of the Family reduction has occurred, perhaps owing to their minute size, leading to the complete disappearance of the avicularia.

1. **Chlidonia** Lamx.

"Chlidonies" Savigny, DE, Pl. XIII.
chlidonia Lamouroux, 1824, EncM, Livr. 95, p. 192.
Chlidonia D'Orbigny, 1851, PFTC, p. 40.
Cothurnicella Wyville Thomson, 1858, NHR, V, p. 141.
Genotype, *Vorticella polypina* Esper et auctt. (*nec* Linn.) = *C. cordieri* auctt. See Harmer, 1923, JLS, XXXV, p. 305.

The genus is regarded as including one species only; and its characters, as given by Levinsen (1909), must for the present be considered as identical with those of the species described below.

1. *Chlidonia pyriformis* (Bert.). (Pl. XV, figs 10, 11).

Vorticella polypina Esper, 1798—1806, Pflanzenth. Fortsetz., II, Vorticella, Tab. 1, figs 1, 2 (nec *Vorticella polypina* L.).
Cellaria pyriformis Bertoloni, 1810, Rar. Ital. Plant. Decas Tertia, p. 112; — 1819, Amoen. Ital., p. 273.

"Chlidonies" Savigny, DE, Pl. XIII, figs 3^1—5^5.
Eucratea cordieri Audouin, 1826, EPS, p. 243; — 1828, EPS, p. 74. Red Sea.
Eucratea cordieri Waters, 1879, AMNH, 5, III, p. 116, Pl. XV, figs 9—11. Naples.
Cellaria vesiculosa Lamarck, 1816, ASV, p. 140.
Eucratea vesiculosa Hammer, 1829, in Esper, Pflanzenth., Theil III, Lief. 16, p. 255.
Chlidonia cordieri D'Orbigny, 1851, PFTC, p. 40. Mediterranean and Canary Is.
Chlidonia cordieri Busk, 1884, Chall., p. 8, Pl XXVIII, fig. 11. Torres Straits, Calvados, Nice, Tyre.
Chlidonia cordieri Hincks, 1886, AMNH, 5, XVII, p. 258. Adriatic.
Chlidonia cordieri Waters, 1896, JRMS, p. 287. New Zealand, Australia; — 1897, JLS, XXVI, pp. 4, 18, Pl. I, figs 8, 9. Rapallo; — 1913, BEA, p. 492, Pl. LXV, figs 15, 16. British E. Africa.
Chlidonia cordieri Calvet, 1902, TIZM, 11, p. 13, Pl. 1, figs 1, 2. Cette; — 1902, TIZM, 12, p. 6. Corsica; — 1907, BTT, p. 373. Bonifacio.
Chlidonia cordieri Graeffe, 1903, AZIW, XV, p. 2. Triest.
Chlidonia cordieri Levinsen, 1909, MSSB, p. 197, Pl. VIII, figs 6*a*—*y*.
Chlidonia cordieri Marcus, 1920, SGNFB, p. 67. Algiers.
Cothurnicella daedala Wyville Thomson, 1858, NHR, V, p. 141, Pl. XI, figs 3—5. Western Australia.
Chlidonia daedala MacGillivray, 1885, PZV, XI, p. 35, Pl. CVIII, figs 2—2*b*. Victoria.

501. B. } Stat. 163. Seget, N. end of New Guinea, 29 M. Fragments.
612. A. }

Zoarium consisting of a creeping stolon, giving off at intervals erect, jointed stems, each subdividing into two branches, every joint of which gives rise, on its distal side, to a secondary branch, consisting of a series of zooecia, all facing in one direction, and frequently ending in a simple or slightly branched thread-like termination, composed of segments resembling those of the stem. Zooecia pear-shaped, carinate basally, with a terminal orifice, the proximal border of which is nearly straight. Aperture separated from the orifice, occupying most of the expanded part of the frontal surface, narrower proximally. Cryptocyst deep, slightly convex proximally, then curved or angulated and forming the proximal wall of a tube-like region leading to the orifice and meeting the base of the operculum; perforated by one or two pores. Avicularia wanting.

Marcus (1920), in discussing this species, expresses the opinion that *Cellaria pyriformis* Bert. is identical with *Catenaria lafontii* Aud. I do not accept this view, for the reasons given by me in 1923. Waters (1896, p. 287) alludes to the possibility that the wide Geographical range of *C. pyriformis* may be due to its distribution by ships. Calvet (1902, TIZM, 11) has given Cape York, Baffin's Bay, as a locality, and this mistake has been quoted by Marcus. The Cape York recorded by Busk is the N. E. point of Australia, in Torres Straits.

501. B (fig. 11) has zooecia which are smaller and more delicate than in Mediterranean specimens, their calcareous parts less thickened, particularly at the proximal end of the frontal surface of the expanded part, and the cylindrical proximal end of the zooecium is longer. This difference in length will be appreciated by comparing fig. 11 with those given by Savigny and others of Red Sea or Mediterranean specimens. But, on the other hand, 612. A (fig. 10), from the same Station, agrees in form with Savigny's figures. The length of the zooecia may be considered a variable feature.

The best account of the structure of *C. pyriformis* has been given by Levinsen (1909). The main cavity of the zooecium was described by him as being subdivided into four sections, in a longitudinal row, but these are less distinctly marked in the Siboga specimens. The segments of the stalk and of other parts have the same four sections and are thus shown to be

kenozooecia, a conclusion confirmed by the occurrence in them of a hypostegia closed by a frontal membrane (see also WATERS, 1897 and CALVET, 1902, TIZM, 11). According to LEVINSEN (1909, Pl. VIII, fig. 6*f*), the cryptocyst is perforated by two pores, one at the base of the distal tube and one more proximally, on one side. I think these two pores occur in the Siboga material, but there may perhaps be a pair of distal pores. WATERS (1913, Pl. LXV, fig. 15) represents a depressor muscle passing through the distal pore to the frontal membrane, and he figures the operculum (fig. 16), which has a minute projection on each side, at its proximal end; a feature specially commented on by WYVILLE THOMSON. This author described certain zooecia as being larger than the rest and regarded them as representing ovicells. MACGILLIVRAY repeats this statement, and WATERS, in the paper just cited, records the occurrence of an embryo in a zooecium. The Siboga slide 612. A^2 includes one of these enlarged zooecia (fig. 10), in which an ovoid egg, filled with yolk, is present in the basal half of the body-cavity. The polypide is very small, and the number of tentacles is probably 8.

2. **Crepis** Jullien.

Crepis Jullien, 1883, BSZF, VII, p. 522.
Crepis Canu, 1900, BSGF, 3, XXVIII, p. 380.
Crepis Calvet, 1907, BTT, p. 393.
Monotypical. Genotype, *C. longipes* Jullien, 1883.

Nothing seems to have been added to the original account of the genus, which was founded by JULLIEN for a new species dredged by the 'Travailleur' at depths of 1068 and 2018 M., between Vigo and Oporto. The type-species consisted of uniserial, creeping zooecia, of oval form, prolonged proximally into a long, tubular portion arising from the preceding zooecium; with raised edges surrounding a large area, closed proximally by an extensive cryptocyst, and with a terminal opesia or orifice. To these characters may be added, on the evidence of the Siboga material: — Zoarium erect and jointed or repent and unjointed. Zooecia resembling those of *Chlidonia*, but with the cryptocyst less developed, not reaching the operculum. Vicarious avicularia sometimes present.

1. *Crepis longipes* Jullien (Pl. XV, fig. 19).

Crepis longipes Jullien, 1883, BSZF, VII, p. 522, Pl. XVII, figs 60, 61.

501. P. Stat. 163. Seget, N. end of New Guinea, 29 M. On *Scrupocellaria*. 2 zooecia only.

Cambridge, Mus. Zool.: —

BM Singapore, 6 fath. R. HANITSCH, Reg. Apr. 10, 1900. On a Hydroid.
Singapore, 7 fath. F. P. BEDFORD, Reg. Nov. 11, 1899. On *Scrupocellaria ferox*.

British Museum: —

Port Darwin (N. Australia), "Alert", 82. 2. 23. 16. On basal surface of *Retiflustra cornea*, 82. 2. 23. 15.

In spite of the great difference in locality and depth I cannot distinguish these specimens from *C. longipes*, as described by JULLIEN. They differ from the next species in the uniserial,

ungrouped arrangement of the zooecia, in their less raised margins, in the approximately horizontal position of the frontal membrane, and in the fact that all the zooecia have a long, tubular, proximal portion. Lateral zooecia are freely budded off from near the middle of the expanded part of the zooecia, as in JULLIEN's account. The operculum is small, occupying the distal half of the terminal opesia.

2. *Crepis verticillata* n. sp. (Pl. XV, figs 13—18).

Cambridge, Mus. Zool.: —

BM Torres Straits, 121, 141 (Type), A. C. HADDON, Reg. Feb. 24, 1898. Principally on the Hydroid *Eudendrium infundibuliforme* Kirkpatrick, 1890, TS, p. 606.

Zoarium minute, creeping, composed of a narrow, filiform tube, dilating at intervals into an oval zooecium (really the distal region of a zooecium), which is usually associated with one to four others, forming a whorl, partially encircling the substratum. The tubular, proximal part of the zooecium is suppressed in the lateral members of the whorl. Greater part of the opesia filled with a cryptocyst, much depressed at its deepest part, and resembling that of *Chlidonia*. Margin of zooecium much elevated, especially distally; the plane of the oval aperture being thus at an angle with the proximal part of the zooecium. Avicularia wanting.

The principal differences between *C. verticillata* and *C. longipes* have been indicated under the preceding species, and among them I attach special importance to the verticillate arrangement of the zooecia of the present species, the raised distal ends of the zooecia coupled with an oblique position of the frontal membrane, and the suppression of the tubular, proximal ends of the lateral zooecia. The angle formed by the plane of the frontal membrane with the substratum may be 45° or less (figs 16, 17), but in other cases (fig. 18) the distal end is so much raised that the frontal membrane is transversely vertical.

The narrow, stolon-like portion, which is closely attached to the Hydroid and connects the groups of zooecia, consists of the proximal end of the median zooecium of the distal group (fig. 15). This is closely associated, generally on each side, with one or two lateral members of the whorl; and, whatever their number, none of the lateral members possess a tubular proximal portion. In a lateral view of a median zooecium (fig. 17), the tubular part is seen to originate from its predecessor in much the same way as in *Chlidonia*; an oblique, incomplete septum partially cutting off a small chamber at the basal side of the terminal wall of the parent zooecium.

The zooecial walls and the cryptocyst are well calcified, but in a basal view (fig. 14) it is seen that the attached wall is incompletely calcified, leaving an elongate fenestra in the median zooecium and a more oval fenestra in the others. The median zooecium, at the proximal end of its widened part, has a blister-like rosette-plate on each lateral wall. A similar arrangement may occur on the outer sides of the lateral zooecia, in a corresponding position; and a more distally placed communication-plate may be found at the base of the terminal wall. In one case (fig. 14) this distal plate was observed to give rise to a delicate, calcareous rootlet. I have not observed any branching of the main axis of the colony, but a rootlet of the kind just described may perhaps form the commencement of a new axis.

3. *Crepis decussata* n. sp. (Pl. XV, figs 6—9, 12).

(a) (figs 6—8).

Type. 162. A. Stat. 227. Banda Sea, S. of W. end of Ceram, 2081 M.
182. B. Stat. 260. Kei Is, 90 M. Fragments only.

Zoarium Hydroid-like in appearance, composed of cylindrical, erect stems, the branches dichotomous and jointed at their bases. Internodes consisting of 3—7 decussate pairs of zooecia or avicularia, the distal parts of which stand out freely from the main axis. Proximal parts of the zooecia and avicularia very long and tubular, immersed in the internode. Distal parts of the zooecia joining the proximal parts at little more than a right angle, spoon-shaped, the proximal surface concave and bearing the frontal membrane. Avicularia provided with a polypide, replacing zooecia, which they resemble in general form, except that the distal part joins the proximal part at a more obtuse angle and is not spoon-shaped, although provided with a frontal membrane in a position corresponding with that in which it occurs in the zooecia. Mandible curved, triangular at its base, acicular terminally, possessing a basal sclerite, a structure which is absent in the opercula. Cryptocyst very small, forming a lip guarding the opening between the proximal and distal parts, in both zooecia and avicularia.

(b) figs 9, 12).

526. F. Stat. 211. S. of Celebes, 1158 M.
155. B. Stat. 211, on *Levinsenella carinata*, 155. A.
529. B. Stat. 221. Banda Sea, 2798—3112 M., on *L. carinata*, 529. A.

Zoarium repent, uniserial, without avicularia.

The specimens indicated above, under (b), are very different, at first sight, from the others, and they may possibly belong to a different species. They agree so closely with (a), however, in zooecial characters that I have thought it best to regard them merely as repent forms, of the same species, which have not given rise to the characteristic erect condition of the type.

The Stations at which this species was obtained (assuming the identity of the two forms distinguished above) are nearly in one line, crossing the Banda Sea from a point off the S. of Celebes to the Kei Is, S. of the W. end of New Guinea. The fragments from Stat. 260 are from the comparatively small depth of 90 M.; but the others are from depths ranging from 1158 to 3112 M. The species may clearly be regarded as a deep water form.

C. decussata, as represented by the erect form, is one of the most interesting species obtained during the Expedition. In the possession of avicularia retaining a functional polypide it is exceptional, although agreeing with *Steganoporella*.

The type-specimen (162. A) might well be mistaken for a Hydroid at first sight. It consists of nearly cylindrical stems (fig. 7), dichotomising from time to time, composed of four series of zooecia arranged decussately in pairs, and slightly flattened in the plane of each pair of zooecia. Immediately above the bifurcation, each of the two branches is jointed at its base. The joint is formed as in other Polyzoa, the calcification being at first complete, a ring of it being absorbed later, leaving the chitinous lining to form the actual joint. The internodes are usually about 3·3 mm. in length and are mostly composed of 5 pairs of zooecia, the distal couple at right angles to the plane of bifurcation. The nearly cylindrical parts of the internode consist of the

sum of the greatly elongated, narrow, proximal parts of the zooecia or avicularia, each of which originates from its immediate predecessor in its own longitudinal row. The walls are calcified in all parts except on the proximal side of the free distal portion, which is closed by a delicate frontal membrane, depressed into the cavity of the zooecia in the mounted specimens, but probably stretched more tightly across it during life.

The spoon-shaped portion of the zooecium makes not much more than a right angle with the tubular part, and its distal calcified wall passes continuously into that of the adjacent part of the stem. The arrangement is different on the proximal side of the spoon, where the frontal membrane passes into the stem on the proximal side of a lip-like calcareous cryptocyst, which projects into the body-cavity at the junction of the two parts of the zooecium. In frontal view (fig. 7), the opening which connects the cavities of the two parts resembles the orifice of certain Lepralioid forms, and may even be somewhat trifoliate, as in the middle zooecium shown in the figure. It will be observed that, in the zooecia seen from this aspect, the frontal membrane terminates on the proximal side of the lip-like cryptocyst.

The opercula are of Membraniporine type, with a crescentic marginal sclerite, but without a basal sclerite. The retracted polypide lies almost entirely in the proximal part of the zooecium, the tips of its tentacles sometimes just extending into the base of the spoon. The tentacles are few, perhaps not more than ten. The pharynx is well marked, but the alimentary canal is very slender and it resembles that of *Aetea* in retraining its U-shape when retracted, instead of being folded, as in most Cheilostomes with relatively shorter zooecia.

The avicularia (figs 6—8) resemble the zooecia in their proximal portion and in the lip-like cryptocyst. The distal part is more nearly in line with the tubular part than in the zooecia, and it is thus directed towards the distal end of the internode. Its proximal surface is covered by an uncalcified frontal membrane, but its mandible is terminal, instead of lying in the plane of the frontal membrane, as in the zooecia. The mandible is strong, curved as seen in side view, triangular at the base, and acicular distally, its tip just overlapping the end of the avicularium. Its base is prolonged into the body-cavity as a triangular flange (fig. 8), a structure also present in the operculum (fig. 7), from which it differs in having a basal sclerite (fig. 6), followed distally by a thinner chitinous region, as in the mandibles of many other Cheilostomes. The occlusor muscles, like those of the opercula, are inserted into the tips of the two flanges (fig. 8). Some of the fibres originate from the lateral walls of the distal part of the avicularium, but a strong group of longer fibres originate from the basal wall of the proximal part, as shown in figs 7 and 8. There are thus two pairs of mandibular occlusors, as in *Steganoporella*.

The individuals thus modified as avicularia are commonly the penultimate pair of an internode, but they are not present in all internodes; and, in at least one case, one of the two zooecia of a pair is modified as an avicularium, in addition to two others on its proximal side.

The avicularia are provided with a polypide, which resembles those of the zooecia and is certainly functional. The retention of the polypide is a highly interesting fact, and in this respect *C. decussata* resembles *Steganoporella*. The small cryptocyst at the junction of the two regions, in both zooecia and avicularia, represents the more highly developed tube of *C. verticillata* and of *Chlidonia*. The type-material, from Stat. 227, consists of a number of small pieces, which have obviously been detached from some other object. They give off one or two rootlets,

but no other evidence as to their mode of attachment was obtained, and there is no trace of a uniserial portion. The small fragments from Stat. 260 agree closely with the type-specimen, in spite of the comparatively small depth from which they were obtained.

The specimens (figs 9, 12) from Stations 211 and 221 differ from the type-specimen in being repent (mostly on *Levinsenella carinata*) and uniserial. The distal parts of the zooecia are rather shorter, and broader at the base, than in the type; and avicularia have not been found. The colony commences with a small oval disc (fig. 9), produced into a narrow, vertical tube which is the proximal end of the first zooecium. This bends at right angles at its middle and then passes into its distal portion. A daughter-zooecium is given off at the principal bend, lying in the same line as the second half of the primary zooecium, the spoon-shaped portions of the two facing one another. Other uniserial colonies (fig. 12) are attached by the basal surfaces of the tubular parts of their zooecia to the Polyzoon on which they are growing; and an occasional rootlet is produced.

The repent form is of particular interest in showing that *C. decussata* is referable to *Crepis*; since it closely resembles *C. longipes* except in the elevation of the distal portions of the zooecia and in their angular junctions with the proximal portions. *Crepis* appears to be a genus in which vicarious avicularia were originally present, although they are known to occur in *C. decussata* alone. Its cryptocyst may show a tendency to reduction, as compared with that of *Chlidonia*, which in respect of its more developed cryptocyst may be regarded as more primitive in character.

Division 4. Pseudostega.

Pseudostega Levinsen, 1909, MSSB, pp. 90, 207.

Fam. 1. Aspidostomatidae.

Aspidostomidae Jullien, 1888, CH, p. 77.
Aspidostomidae Canu, 1908, AMNBA, XVII (3, X), p. 276.
Aspidostomidae Levinsen, 1909, MSSB, p. 170.
Aspidostomidae Canu and Bassler, 1917, USNMB, 96, p. 30; — 1920, USNMB, 106, p. 252.

This Family was established by Jullien for *Aspidostoma crassum* Hincks, on the ground of peculiarities of the orifice which were not expressly stated; and he placed it near the Onychocellidae. Levinsen called attention to the absence of spines, the prominence of the distal end of the zooecium, the opesiules (lateral recesses), the "polypide-tube", the avicularia and the occasional occurrence of "hyperstomial" ovicells.

The Family is characterised by the possession of a tube or median process, comparably with that of *Steganoporella*, but with different relations to the cryptocyst, which typically has two longitudinal ridges, uniting with one another on the distal side of the orifice, and has no thickened postoral shelf. It further differs from that genus in the characters of the avicularia, in the bilaminar opercula and mandibles, and in the possession of ovicells (not hyperstomial) provided with independent orifices.

The Aspidostomatidae appear to combine some of the characters of the Steganoporellidae

and of the Onychocellidae; the affinity to the latter having previously been suggested by JULLIEN. They have advanced beyond the *Steganoporella* stage in the structure of their avicularia, which have lost their polypide; and the opercula and mandibles are strikingly different. The characters of the ovicells seem to place them near the Cellariidae.

1. **Aspidostoma** Hincks.

Aspidostoma Hincks, 1881, AMNH, 5, VII, p. 159.
Aspidostoma Busk, 1884, Chall., p. 161.
Aspidostoma Canu, 1908, *loc. cit.*
Aspidostoma Levinsen, *op. cit.*, p. 171.
Monotypical. Genotype, *A. crassum* Hincks, 1881, generally regarded as a synonym of *Eschara gigantea* Busk, 1854, BMC, p. 91.

Cryptocyst-ridge surrounding the orifice distally, sometimes with a projecting lobe on either side of the opesia. Median process forming a frontal lip depressed proximally, with a more or less everted edge; on either side of it an emargination or opesiule. Avicularia vicarious or adventitious. Ovicells immersed in the next zooecium.

Descriptions referring to *A. crassum* and other species will be found in the Memoirs of BUSK (1884, p. 161), WATERS (1888, Chall., p. 28), JULLIEN (1888, CH, p. 77), CANU (1908, p. 276; — 1911, AMNBA, XXI (3, XIV), p. 253) and LEVINSEN (1909, p. 171).

1. *Aspidostoma cylindricum* n. sp. (Pl. XXII, figs 1—4).

Type. 478. D. Stat. 107. Sulu Archipelago, 270 M.
535. A. Stat. 226. Off Lucipara Id, Banda Sea, 1595 M.

Erect, cylindrical, Vincularian, attached by a bundle of chitinous rootlets. Zooecia opening all round the branch, quincuncial, in longitudinal rows, usually with four zooecia at the same transverse level (Fig. 4). Cryptocyst imperforate, minutely granular or tuberculate. The cryptocyst-ridge is generally raised into a prominent, minutely denticulate ridge on either side of the opesia; the distal part is less raised; the proximal part, on each side, is situated at some distance from the lateral margin of the zooecium, not reaching its proximal end. The interval between the lateral parts of the ridge is depressed, but its median part may bear a distinct ridge, commencing near the proximal end of the zooecium, where it is broad, but becoming narrower as it passes distally to the base of the median process. Tube, as in other species, represented by an oral lip or median process, at the proximal end of which is a deep depression of the hypostegia, outlined by a more or less vertical, somewhat everted distal edge, and by less prominent lateral edges. Opesiules small. Avicularia large, vicarious; the mandible subtriangular, or semicircular distally with the sides parallel proximally.

A. cylindricum differs in habit from some other members of the genus [1]); but its zooecia closely resemble those of the type-species, in their old condition at least. In this state the cryptocyst-ridge becomes much flattened, while the conspicuous median ridge gives them a strong

1) *A. airense* Maplestone (1902, PRSV, N. S., XIV, p. 71) and *A. otwayense* Mapl. (1911, PRSV, N. S., XXIII, p. 280) are Vincularian species from the Tertiary of Victoria.

resemblance to *A. giganteum*, as described by HINCKS (1881, p. 160) and LEVINSEN (1909, Pl. VI c, fig. 2*a*). The walls of the zooecia are thick and highly calcified, as in other species.

In the young condition (fig. 1), the cryptocyst is much raised distally into two prominent lobes, the edges of which are finely denticulate. The orifice lies in a deep longitudinal groove between them, and its distal margin is lower, the projections commencing abruptly. I have not been able to decide whether there is a descending cryptocyst; which, according to LEVINSEN (p. 172), partly joins the basal wall in *A. giganteum*.

In 478. D (fig. 1) some at least of the zooecia, although becoming very narrow proximally, reach the next zooecium on their proximal side. In 535. A, each zooecium is separated from its predecessor in the longitudinal row by the alternating zooecia, the lateral margins of which unite, as often in the Cellariidae, in a longitudinal suture which connects the proximal and distal ends of two zooecia in the next row. The zooecia are thus either quadrangular and lozenge-shaped, with their angles median and lateral; or hexagonal, with two short lateral sides. In the fully grown condition, the zooecia are arranged in alternating whorls of four. In 478. D there is a small fragment, attached to the surface of the larger colony by a bundle of chitinous rootlets, and composed of very small zooecia, arranged in pairs, mostly back to back. The first two pairs face in the same direction, the next pair at right angles to the first and second; while there are four further pairs with a regular, decussate arrangement, the last pair incompletely developed and the branch slightly widening at the end. No median zooecial ridge is present, but the cryptocyst-ridge is prominent and typical. Although the zooecia are much smaller than in the other specimens, this fragment seems to be a young stage of the present species, probably developed from a larva which attached itself to an older colony.

The median ridge of the zooecium is not distinct in 478. D, but is strongly developed in 535. A; and I have added it, from this specimen, to the lowest zooecium shown in fig. 1. Its surface is marked by delicate longitudinal ridges.

The ovicell is immersed in the next zooecium, and its full extent is not shown in fig. 1. Its orifice is an independent one, situated on the distal side of the zooecial orifice, as in *Cellaria*.

Only one or two avicularia have been found. As seen near the upper end of fig. 1, the avicularium is vicarious and of large size, the mandible being in this case subtriangular. The opesia extends beyond the base of the mandible, proximally, as shown.

The opercula (fig. 2) have the same structure as in *Lagarozoum*, described below; being composed of two horizontal layers, which are widely separated from one another. The outer is part of the frontal membrane and is connected, distally and laterally, with the smaller inner layer by an obliquely vertical wall. The inner layer, shaded in the figure, is much more strongly chitinised than the outer layer. Its proximal end is prolonged into two elongate processes, corresponding with the opesiules. Similar projections have been shown by WATERS (1888, Chall., Pl. III, fig. 21), in *A. giganteum*; but the two species differ greatly in the shape of the operculum, which is longer than wide in *A. cylindricum*. The occlusor (*occ.*) and divaricator or depressor (*dep.*) muscles are shown in fig. 2.

The mandible (fig. 3) has a remarkable structure, but it has some resemblance to that of *A. giganteum* (WATERS, 1888, Pl. III, fig. 20). On the basal side, the proximal border is prolonged into a half tube, through which runs the tendon of a strong muscle, apparently a

proximal occlusor, but on the frontal side there is no corresponding half tube. It thus appears that in the mandible, as in the operculum, the sclerites are formed from the inner layer. The basal sclerite is very strong and gives off an arched main sclerite, the proximal parts of which converge in a curve, uniting more distally, as shown in the figure. These arched parts are most thickened in their outer parts, and between them lies a median fenestra, pointed distally and covered by thinner chitin. The main occlusor tendons (*occ.*) are inserted along a line, on either side of the distal, united part of the two halves of the main sclerite. The mandible is provided distally with a curved sclerite (*d. s.*), which forms a biting edge.

2. Lagarozoum [1]) n. gen.

Zooecia in distinct longitudinal rows or irregularly arranged, their proximal ends underlying parts of the adjacent zooecia. Cryptocyst-ridge ∩-shaped; horizontal part of cryptocyst deeply depressed, ending distally in a prominent frontal lip, which joins the sides of the oral arch laterally. Outer layer of operculum thin, inner layer strongly chitinised. Avicularia vicarious. Ovicells immersed, a small portion only being visible in frontal view. Genotype, *L. profundum* n. sp.

1. *Lagarozoum profundum* n. sp. (Pl. XXII, figs 5—7).

Type. 111.K. Stat. 156. W. of Waigeu Id, 469 M. On a Retepore, 111.E.
403.A. Stat. 251. Kei Is, 204 M. On a stone.

Encrusting, characters as in the genus. Oral arch raised, in some cases prolonged into strong, tuberculate conuli. Proximal parts of cryptocyst-ridge arising from one border of that part of the cryptocyst which overlies part of the adjacent zooecium. Depressor sclerites strong. Avicularia large, asymmetrical, curving round the distal end of a zooecium, the cryptocyst-ridge of which is reduced on the side adjoining the avicularium. Ovicells transversely elongate, about twice as wide as long, extending outwards so as to underlie a pair of large distal foramina in the lateral shoulders of the cryptocyst-ridge.

This highly remarkable species was obtained from two rather deep dredgings, in localities not far apart. Its most obvious feature is the extraordinary depth of the hypostegia, or cavity between the frontal membrane and the cryptocyst; this feature being indicated in the generic and trivial names.

The operculum (fig. 7) consists of two distinct layers, separated by a cavity which extends uninterruptedly to its free margin and is continuous with the part of the body-cavity which underlies the frontal membrane, as indicated by the arrow in the figure. Its bilaminar character was demonstrated by inserting the point of a needle into the cavity, in the position shown by the arrow.

The outer layer of the operculum is a continuation of the frontal membrane, and it has the same delicate texture, without any sclerites. The deep layer, on the contrary, is strongly and uniformly chitinised and is deeply shaded in the figure. Stained with picronigrosin, this thickened part becomes yellow; all the other parts, including the depressor sclerites, having the

1) λαγαρός, "of a sunk, hollow appearance".

blue-black nigrosin colour. The two layers are connected by an obliquely vertical part, seen in the figure distally to the inner layer, the external layer being slightly the larger. The lateral edges of the operculum give rise, proximally, to a triangular flange, into the apex of which the tendons of the occlusors (*occ.*) are inserted; the muscles themselves originating from the lateral walls, under the proximal half of the operculum. Its proximal corners are intimately related with a thickening of the chitinous lining of the oral arch, which forms a socket on each side, into which a corner of the operculum extends. Just proximally to the operculum the membrane forming this socket bends inwards at right angles and is continued proximally as a remarkably strong depressor sclerite (*d. s.*). This has the form of a girder projecting into the hypostegia and dying away proximally. The inner edges of the depressor sclerites, as represented in fig. 7, are those which project into the body-cavity, the outer edges being in the plane of the frontal membrane.

At its junction with the depressor sclerite the thickened chitin of the oral arch projects inwards as a tubercle, partly into which and partly into the adjacent portion of the frontal membrane is inserted the long tendon of the depressor muscle (*dep.*), which appears to originate from the lateral wall in close contact with the occlusor of its side, and just externally to it. The tendon of the depressor runs in a pulley-like surface formed by one of the opesiules seen in fig. 6, at the sides of the median process. The point of insertion, lying as it does close to the projecting calcareous lip, would be unfavourably situated for depressing the frontal membrane if it were not for the fact that the sclerite extends the action of the muscle to the region where the hypostegia is deepest.

The proximal extension of each zooecium on the basal side of its predecessor is closely connected with the form of the zooecia, which are not always arranged so irregularly as in fig. 6. When definite longitudinal rows of zooecia occur, the arrangement is, however, much the same; the basal prolongations being formed either by the bilobed end of a single distal zooecium, or by the two simple ends of two distal zooecia, where a bifurcation of the row occurs. The floor of the deepest part of the hypostegia is constituted by the horizontal cryptocyst. This is strongly tuberculate and is formed by a large number of separate plates (partly indicated in the avicularium) which appear to be separate centres of calcification. Minute pores occur between these platelets, but are not easy to distinguish from the tubercles when these are fully developed. The deeply situated horizontal cryptocyst generally becomes narrower distally, being somewhat bottle-necked as it passes into the median process. From the edges of the horizontal cryptocyst rise the lateral walls of the hypostegia, sloping outwards and frontally. These portions separate the hypostegia from the body-cavity of the underlying zooecium. Before reaching the frontal membrane the lateral portions give off the cryptocyst-ridge, which forms the whole of the oral arch. The lateral parts of the cryptocyst-ridge are nearly horizontal, and they probably serve to support the frontal membrane when it is pulled down by the depressor muscles. The zooecia are outlined by a chitinous line, and the frontal membrane extends completely across the zooecium between opposite parts of this line.

The oral arch is raised and sends off a proximal prolongation on each side. In some zooecia it is simple and tuberculate; but in a few cases it projects into a series of strong, tuberculate conuli, as shown in a zooecium in fig. 6. The oral arch, like other parts of the

cryptocyst, is covered by the frontal membrane, which here has the form of a delicate semicircular bag loosely enclosing the arch, and dipping down between the conuli, if these are present.

The "tube" of this species is constituted entirely by a strong frontal lip, not appreciably everted, ascending rather abruptly from the horizontal cryptocyst and joining the sides of the oral arch. There are thus no subtubular opesiules, these structures being represented by the slight emarginations, on either side of the lip, through which the depressor tendons pass to their insertion. The base-line of the operculum overlies the distal edge of the lip.

The avicularium is large and is typically vicarious. It curves round the distal end of the orifice of a zooecium and is in close contact with it laterally for the whole of its length. The cryptocyst-ridge of the associated zooecium is more or less reduced on the side of the avicularium. The avicularian rostrum is very asymmetrical, and the mandible has a corresponding form. The mandible shown in fig. 6 was turned over during the process of mounting, and the apparent reversal of its asymmetry is a mere accident of preparation. The distal cryptocyst of the avicularium is depressed and is usually traversed by two foramina, representing its opesia, through which pass the occlusor tendons. In one case the foramina are not completely separated, but are represented by a horse-shoe-shaped opesia, resulting from the formation of two calcareous processes from the proximal cryptocyst, projecting distally, closely apposed and in the place of the median septum of fig. 6. The proximal region of the avicularium is longer than the distal region, and the avicularium resembles the zooecia in having a proximal part which underlies the next zooecium, as shown in the figure. In the instance in question this part is completely empty and is cut off from the rest of the avicularian cavity by a complete calcareous septum, which corresponds in position with the frontal edge of the zooecium overlying the avicularium, but I do not know if this arrangement is typical. The distal end of the avicularium is principally occupied by the large occlusors. The mandible has a distinct basal sclerite and a main sclerite, the two halves of which unite to form a median portion which dies away before reaching the distal end.

The ovicells (fig. 5), present in 403. A, resemble those of *Crateropora*, described below. The part visible in frontal view is only a small portion of the whole, and in basal view the ovicell is seen to be greatly elongated in its transverse diameter, which is about twice as great as the longitudinal diameter. The ovicell thus extends laterally as far as the outer edges of the large fenestrae which are found at the distal ends of the lateral shoulders. These fenestrae appear to be closed merely by the frontal membrane, and to be continuous with the cavity of the ovicell, though they may perhaps be separated from it by a membrane. They are probably adaptations facilitating the respiration of the embryo.

3. **Crateropora** Lev. (Pl. XXII).

Crateropora Levinsen, 1909, MSSB, pp. 171, 173.
Crateropora Canu and Bassler, 1920, USNMB, 106, p. 259.
Monotypical. Genotype, *C. falcata* Levinsen, 1909.

Levinsen defined *Crateropora* as a genus of Aspidostomatidae without ovicells, the zooecia with distinct raised margins, the polypide-tube with an expanded distal margin, but not surrounded

by projecting flanges, nor connected with the lateral walls by vertical calcareous laminae; the rosette-plates uniporous. I suggest the following amended diagnosis.

Zooecia in distinct longitudinal rows, with a well marked cryptocyst-ridge. Horizontal, porous cryptocyst occupying the greater part of the frontal surface; not surrounded proximally and laterally by a postoral shelf; extending completely round the distal end of the oral arch. Polypide-tube broad, incomplete basally, the frontal lip usually everted or reflected. Opercula simple. Walls of the lateral recesses joining the distal wall. Avicularia vicarious, but tending to become adventitious in some species. Ovicell immersed in the next distal zooecium, provided with an independent orifice and operculum.

A genus *Euginoma*, with a single new species *E. vermiformis* (the genotype), was introduced by JULLIEN (1883, BSZF, VII, p. 520), but his figures (Pl. XVII, figs 58, 59) are on too small a scale to be satisfactory. CALVET described parts of the same collection twenty-four years later (1907, BTT, p. 355), adopting the inconvenient plan of recording JULLIEN's species as new. His figure (Pl. XXVII, fig. 3) of *E. vermiformis* "nov. sp." (p. 402) has unmistakeable resemblances to my own figure (Pl. XXII, fig. 9), particularly in the form of the cryptocyst-ridge and in the independent orifice of the ovicell. *Euginoma* is referable to the Aspidostomatidae, but it can hardly be considered to include *Crateropora*, since CALVET's figure shows no trace of the tube so characteristic of this genus or of avicularia.

The study of *Crateropora* throws considerable light on the structure of the Aspidostomatidae. The porous horizontal cryptocyst and the conspicuous tube, with a lateral recess on either side of it, are features which suggest an affinity to *Steganoporella*, but a comparison with that genus reveals fundamental differences. The most important of these are the absence, in *Crateropora*, of a postoral shelf and of a dithalamic condition of the zooecium, the presence of differentiated avicularia and ovicells, and the simpler character of the opercula.

The edge of the zooecium is somewhat depressed. A pronounced ∩-shaped cryptocyst-ridge passes continuously round the distal and part of the lateral regions of the zooecium, near its margin. Pores occur on its outer side, along its whole extent; and the frontal membrane originates on the outer sides of these pores, distally as well as laterally. Although not exactly representing the postoral shelf of *Steganoporella*, its function is probably identical in the two genera, since it has the effect of raising the frontal membrane above the greater part of the cryptocyst; and, by deepening the hypostegia, gives room for the action of the depressor muscles in protruding the polypide.

It follows from the arrangement of this ridge that the cryptocyst intervenes between the distal margin and the original oral arch. This condition, which is equally characteristic of many other Cheilostomes, is probably due to a distal growth of the cryptocyst, on either side of the orifice, to the median distal point of the zooecium; and I term these growths the "lateral shoulders". Their morphological nature seems to be clearly indicated in the fertile zooecia (Pl. XXII, fig. 16).

The body-cavity of the zooecia is continuous along its whole length, on the basal side (fig. 18). Except so far as the lateral recesses (*l. r.*) are concerned, the descending cryptocyst, so important in *Steganoporella*, is wanting in *Crateropora*.

The polypide-tube, a distal derivative of the cryptocyst, is incomplete, its basal two thirds

being wanting. It is produced by the formation of a transverse groove across the cryptocyst (fig. 15). In the middle line this groove is shallow, but it becomes progressively deeper as it passes outwards on either side. The lateral recesses thus formed, as well as the more median part of the groove, are rendered more distinct by the reflection of the lip of the tube, but they are not sharply defined on their inner borders by the formation of vertical flanges on the wall of the tube, as in *Steganoporella*. They pass outwards and basally, as well as a little distally, until they reach the distal wall of the zooecium, in some cases perhaps just touching the basal wall as well. By deep focussing, in frontal view, it can often be seen that the everted lip of the tube joins the distal wall, the insertion of each lateral recess into which (fig. 14) is an incomplete circle. The tube may be regarded as a structure over which the tentacles pass during their movements of protrusion and retraction, the reflected lip protecting them from being injured by the distal margin of the cryptocyst.

In order to obtain a clear idea of the anatomy, the zooecia should be examined in basal and lateral views. In basal view (fig. 14), the distal zooecium of a row is seen to be equitant on its predecessor, the median part of which projects distally as a lobe, flanked on either side by the two proximal lobes of the distal zooecium. The origin, from the basal wall, of the terminal wall separating the two zooecia thus has the form, shown in the figure, of an ogee-arch. From this base-line the terminal wall slopes obliquely to the frontal wall; — distally in the middle line, and outwards at the sides, with continuous curves at the various horizontal levels. The insertions of the lateral recesses are seen in figs 11, 14, and are on the terminal wall, in advance of its junction with the basal wall.

These relations are further illustrated by fig. 10, a side view, in which the cavity of a zooecium (*a*) has been opened by a section which passes through one of its proximal lobes (*p. l*). In the background is seen another zooecium (*b*), belonging to the next longitudinal row; and the course of its distal wall, as seen in its lateral part, is visible. The distal wall of another zooecium (*c*) is seen in median section; but it is more nearly vertical than in the species represented in fig. 14, as will be seen from its basal view (fig. 11).

Fig. 18 represents a basal view of a zooecium from which the entire basal wall and the basal part of the distal wall have been removed, in a third species of *Crateropora*; but the anatomical arrangements are fundamentally similar in all the species examined. The opesia (*op.*) is bounded distally by the distal wall of the zooecium, at the sides by the walls of the lateral recesses (*l. r.*), and proximally by the lip of the tube. The reflected part of the lip is naturally not visible in this view, but by comparison with frontal views (fig. 16) it will be understood that the inner wall of the lateral recess is continuous with the lip of the tube. On the proximal side of the opesia is a convex region (fig. 18), the basal wall of the groove which gives rise to the tube on the frontal side. The cryptocyst-ridge is a solid structure, developed on the frontal surface; and its relation to the lateral recesses is accordingly not visible in basal view.

The cryptocyst is a horizontal lamina, reaching all four vertical walls, and having no free edge except the lip of the tube. The lateral recesses look like complete tubes, but the frontal view (fig. 16) shows that they are deep grooves, open frontally. The actual junction of the lateral parts of the cryptocyst with the distal wall is not visible in fig. 18, and frontal views show that this occurs nearer the frontal surface.

I have some reason to think that the operculä are composed of two layers, a character which is probably constant in the Aspidostomatidae. The polypides, which are not present in the avicularia, have a definite relation to one of the proximal basal lobes of the body-cavity. The retractor muscles originate at the end of one of these lobes, so that the retracted polypide lies with its tentacle-sheath stretched out between that corner of the zooecium and the orifice. Most of the alimentary canal lies along the curved basal part of the proximal wall. The tentacles are numerous, apparently more than 20.

The avicularium is not bilobed proximally, but it reaches the basal wall in *C. falcata*, and is thus definitively vicarious. Its cavity is occupied largely by the strong occlusor muscles, which originate from the basal and lateral walls. In the zooecia, the fibres of the depressor muscle originate from the distal wall (fig. 11, *dep.*), inside the circular insertion of the lateral recesses. Each passes along the lateral recess, converging into a tendon which is inserted into the frontal membrane slightly to the inner side of the proximal lateral projection of the operculum. I have not found divaricator opercular muscles, but the depressor muscles probably perform the operation of opening the operculum. Situated as they are at the point where the hypostegia is deepest, they are well suited to produce an effective pull on the frontal membrane, and therefore on the operculum, the base-line of which coincides with the lip of the tube. The occlusors (fig. 11, *occ.*) originate from the distal wall, on the frontal side of the insertions of the lateral recesses.

The lateral communication-pores (fig. 10) are a curved series of uniporous septula; which is in accordance with LEVINSEN's diagnosis.

Ovicells have been observed in two species (figs 9, 16). They are immersed in the next succeeding zooecium, opening to the exterior by an ooecial orifice, closed by an operculum of its own, immediately on the distal side of the zooecial orifice. The lateral shoulders of the cryptocyst are incomplete distally, in the fertile zooecium, where they are separated by the median part of the ovicell. The distal pore of each lateral shoulder is a large fenestra in the wall between the shoulder and the ovicell.

Key to the Siboga species of *Crateropora*.

1	Avicularia unilateral	2
	Avicularia paired, short and spatulate	3. *C. foraminata.*
2	Mandible subtriangular, very asymmetrical	1. *C. falcata.*
	Mandible much widened distally	2. *C. expansa.*

Onychocella cucullata Thornely (1905, PGM, p. 111, Plate, fig. 1) belongs to this genus, as I have satisfied myself by the examination of specimens from Ceylon which were presented by Miss THORNELY to the British Museum (06. 12. 3. 1. 2) and the Cambridge Museum (Reg. Feb. 22, 1906, 3, 4) respectively. It differs from the three Siboga species in having elongate mandibles, narrow proximally and bifurcated distally. The ovicells, which are mentioned by Miss THORNELY, have the same general character as in the Siboga species.

1. *Crateropora falcata* Lev. (Pl. XXII, figs 14, 15).

Crateropora falcata Levinsen, 1909, MSSB, p. 173, Pl. VI, fig. 1*a*.

393. A. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M. On the lower side of a Perforate Coral.

Encrusting. Zooecia oblong, longer than wide, distal end prominent. Cryptocyst-ridge strongly tuberculate, originating at a varying distance from the proximal end, on either side, and thence passing along the sides of the zooecium and round its distal end. A narrow oral shelf, on which the operculum closes, occurs on the distal side of the orifice. The horizontal cryptocyst, which is everywhere tuberculate, has numerous pores, some situated on the outer side of the ridge. Tube broad, with an everted margin most developed laterally. Avicularium asymmetrical, on one side of an orifice, round which it is curved. The cryptocyst is deficient on the side of the zooecium thus related to an avicularium, the edge of which almost touches its operculum. Distal opesia of avicularium pear-shaped, narrower distally, where it ends at the level of the union of the two halves of the main sclerite of the mandible.

This species was found by LEVINSEN on the shell of a *Tridacna* of unknown locality. The Siboga specimen agrees closely with LEVINSEN's figure, particularly in the shape of the avicularium, and in its relation to the orifice of a zooecium. The general structure is described above, in the account of the genus.

The terminal wall of the zooecium slopes from the basal wall, in a distal direction, to the frontal wall. A basal view is shown in fig. 14. The distal part of the zooecium is much raised, and its free edge may be produced into 4—7 low, conical projections, like those found in *C. expansa* (fig. 9). Although the lateral recesses end typically on the distal wall, the proximal edge of their insertion is sometimes very close to the union of that wall with the basal wall; and it may perhaps actually reach the basal wall in some zooecia.

In fig. 15 the distal opesia of the avicularium is, for the most part, concealed by the mandible, only a small part of it appearing on the proximal side of the base of that structure. A pore occurs in the middle of the proximal cryptocyst. The distal end of the mandible is acutely pointed.

The opercula are rather delicate, their base-line being situated over the edge of the tube, and their basal end giving off a pointed, incurved proximal projection on each side. They possess a triangular flange on their inner surface, as shown in fig. 8 (*C. expansa*), and the occlusor muscles pass into the apices of these flanges. Ovicells have not been found.

LEVINSEN (1909, p. 174) indicated that *Steganoporella patula* MacGillivray (1895, TRSV, IV, p. 54) may belong to this genus. It is not obvious what was the evidence on which MACGILLIVRAY referred his specimens to *Micropora patula* Waters (1881, QJGS, XXXVII, p. 326).

2. *Crateropora expansa* [1]) n. sp. (Pl. XXII, figs 8—13).

108. J[1]. Stat. 144. S. of Halmaheira (Djilolo), 45 M. Bilaminar.
Type. 543. B. Stat. 260. Kei Is, 90 M. Encrusting.

Encrusting or erect and bilaminar. Zooecia usually wider than long, the distal end very

1) Referring to the mandible, which is widened distally.

prominent. Cryptocyst-ridge massive, its distal edge much raised and terminated by tuberculate projections, its general arrangement as in *C. falcata*. Oral shelf more developed than in that species, its free edge forming an ogee-curve. Horizontal cryptocyst tuberculate and porous, the pores not extending to the base of the tube; a line of pores round the outer side of the cryptocyst-ridge. Tube broad, its lip not or but slightly reflected. Avicularia asymmetrical, on one side of an orifice, nearly touching the operculum; the mandible elongate and widened distally. The cryptocyst-ridge of the associated zooecium is reduced, but is not wanting opposite the avicularium. Distal opesia of avicularium elongate, narrow. Proximal prolongations of opercula much incurved, hook-like. Ovicell immersed in the next zooecium and covered by its cryptocyst, with a nearly semicircular operculum, situated on the distal side of the zooecial operculum. The lateral shoulders of the cryptocyst do not meet on the distal side of the orifice of the fertile zooecium.

This species differs from *C. falcata* in well marked characters. The zooecia are more robust and are usually wide and short, with curved sides, instead of being elongate and with straight sides. The distal margin is more raised, the highest region being the curved distal part, which bears a series of about 7 distinct tubercles (fig. 9). From the outermost of these, on either side, the cryptocyst-ridge slopes down steeply, and generally in a straight line, which forms the lateral boundary of the opesia.

The examination of young, incompletely calcified zooecia (fig. 12) confirms the view that the cryptocyst extends round the distal margin of the orifice in *Crateropora*. The "chitinous line", in other words the uncalcified edge of the vertical walls which outline the zooecia, is distinct in the figured specimen. The cryptocyst-ridge (*c. r.*) is partially formed, having originated at some distance from the margin; and the flattened region outside it bears pores, in series with those of the porous proximal cryptocyst. A few pores are present on the inner side of the ridge, between it and one of the lateral recesses. The whole of the porous region is clearly one structure. The distal wall of the zooecium takes no part in the formation of the orifice.

The most distinctive feature of *C. expansa* is the avicularium (fig. 9), which is less asymmetrical than in *C. falcata*, and is differently related to a zooecial orifice. In transverse section the avicularium is triangular, its lateral walls converging basally, so as to meet in a straight line, which just fails to reach the basal surface. It thus has no basal wall and is accordingly not so completely vicarious as in *C. falcata*. The avicularium is very flat frontally and its edge is hardly raised. The distal portion is the larger and is traversed by a narrow, elongate opesia; a pore being visible in the smaller proximal portion. The relations of the tube to the lateral recesses are as in the other species.

The opercula (fig. 8) are thicker than in *C. falcata*, and are brown in the dry state. They have no definite sclerite, the whole operculum being of practically uniform thickness and sharply marked off from the frontal membrane. A slight thickening occurs, however, at the curved margin. Large triangular flanges are found, for the insertion of the occlusor tendons. The proximal lateral projections are hook-like, and so much incurved as to be parallel to the base of the operculum. The mandible (fig. 13) is elongate, narrow proximally, much widened distally, where it is not quite symmetrical. Its inner surface is concave and spoon-shaped.

Depressor sclerites are wanting, the respective muscles being inserted into the frontal

membrane in the same position as in *C. falcata*. The origins of these muscles (*dep.*) and of the occlusors (*occ.*) are shown in fig. 11, a basal view.

The ovicell (fig. 9) forms a perceptible swelling on the frontal surface, but is completely covered by the cryptocyst of the distal zooecium. The lateral shoulders of the cryptocyst do not unite distally, being separated by part of the ovicell. A distinct ooecial operculum is present, nearly semicircular, and of the same colour as the ordinary opercula. Instead of bearing a series of small pores all along their course, as in the ordinary zooecia, the distal end of each lateral shoulder is occupied by an elongate fenestra, which is usually only visible partially in frontal view. This extends longitudinally about as far as the middle of the ovicell, and is a vacuity in the calcareous wall separating the lateral shoulder from the cavity of the ovicell. The operculum of the fertile zooecium is much broader and shorter than the ordinary opercula, being considerably wider than long. It closes on a well developed oral shelf, and the free edge of the wall which bears this shelf is thin, forming a separation between the opercula of the zooecium and the ovicell. The wall of the ovicell is complete, so that its cavity does not communicate with that of the fertile zooecium.

Levinsen (1909, p. 171) described the ovicells of Aspidostomatidae as hyperstomial; but, as he defined hyperstomial ovicells (p. 60) as being always outside the cavity of the zooecium, *Crateropora* does not agree with his statement (see his diagrammatic figures, Pl. XXIV, figs 12—18). The morphology of the ovicells of this Family is discussed below, on p. 340, under *Cellaria punctata*.

The ovicells appear to be empty, but it seems to follow from their structure that the egg must pass into the ovicell through its orifice, probably after it has reached the exterior, in the way described by Gerwerzhagen in *Bugula* (see p. 203).

3. *Crateropora foraminata* n. sp. (Pl. XXII, figs 16—18).

550. A. Stat. 305. Solor Strait, E. of Flores, 113 M.

Encrusting. Zooecia variable in shape, frequently oblong, and much longer than wide, but sometimes short and wider than long. Distal end not much raised, the ∩-shaped cryptocyst-ridge less prominent than in the other species, and usually confined to the distal half of the zooecium. Oral shelf small. Tube broad, its lip hardly reflected medianly, considerably reflected laterally. Avicularia paired, on either side of the orifice; the mandible short and spatulate. Avicularian opesia broad, not much longer than wide. Proximal prolongations of operculum straight or slightly curved, directed obliquely inwards. Ovicells immersed in the next zooecium, with a relatively large operculum, on either side of which is a wide fenestra in the distal end of the lateral shoulder of the cryptocyst.

The trivial name is suggested in allusion to the three conspicuous foramina [1]) formed, in the fertile zooecia, by the orifice of the ovicell and the two distal fenestrae of the cryptocyst. These fenestrae correspond with those of *C. expansa*; but, as they face frontally, they are much more conspicuous, besides being more rounded than in that species. The zooecia vary much in shape, within the limits of a single colony. Those shown in fig. 16 are oblong, but others (fig. 18)

1) A similar arrangement is found in *Larnacicus cornigera* (Busk), as figured by Norman (1903, AMNH, 7, XII, Pl. VIII, fig. 3), but I doubt whether the resemblance has any significance.

have much the same shape as those of *C. expansa*. The differences depend partly on the way in which new zooecia are developed. A broad zooecium may give rise to two distal successors, which are narrow. The opposite condition may also be found; the dividing line between two rows dying away in such a manner that a single, broad zooecium is developed at the distal end of two narrow zooecia belonging to adjacent rows.

The cryptocyst-ridge is but little raised distally, and its remaining part is also low and short. The limiting "chitinous line" is specially clear, and its relations in the fertile zooecia confirm the view that the distal wall of the ovicell corresponds with the same wall in a zooecium. The basal walls of the lateral recesses are shown in fig. 18.

Avicularia (fig. 17) have been found in a single zooecium only. They are paired, at the sides of the orifice, to which they are related in such a way as not to interfere with the normal development of the cryptocyst-ridge. They do not reach the basal surface of the colony. In form they differ widely from those of the other species, the mandible being short and spatulate, and the oral arch and cryptocyst being much depressed. The opercula are broader than long, sometimes much broader. Their proximal prolongations are straight or slightly curved. The depressor muscles (fig. 17, *dep.*) have been very clearly seen in this species

Fam. 2. Cellariidae.

Cellariidae Hincks, 1880, BMP, p. 103; et auctt.
Cellariidae Canu and Bassler, 1920, USNMB, 106, p. 269.
Salicornariadae (pars) Busk, 1852, BMC, p. 15.
Cellulariidae Levinsen, 1909, MSSB, p. 209 (nec auctt.).

Jointed or unjointed. Opesia completely surrounded by the cryptocyst, often at a considerable distance from the distal end of the area, which is outlined by ridges, generally hexagonal or lozenge-shaped. Zooecia in longitudinal rows, but commonly appearing to be alternate; the longitudinal arrangement, which is demonstrated by the relations of the body-cavities (text-fig. 13, on p. 336), being frequently masked by overgrowths of the alternate zooecia over the proximal ends of their successors. Cryptocyst imperforate, spines wanting. Avicularia vicarious. Ovicells generally inconspicuous in frontal view and provided with an independent orifice. (Their morphology is discussed below, under *Cellaria punctata*).

The Siboga Collection includes two deep water species which I regard as the respective types of two new genera, *Atelestozoum* and *Syringotrema*.

1. **Cellaria** Ell. and Sol.

Cellularia (pars) Pallas, 1766, EZ, p. 58.
Cellularia Norman, 1903, AMNH, 7, XI, p. 577.
Cellularia Levinsen, 1909, MSSB, p. 90.
Cellaria (pars) Ellis and Solander, 1786, NHZ, p. 18.
Cellaria (pars) Lamarck, 1801, SASV, p. 382.
Cellaria (pars) Lamouroux, 1812, MPC, p. 183; — 1816, PCF, p. 123.
Cellaria (pars) D'Orbigny, 1851, PFTC, p. 26.

Cellaria Hincks, 1880, BMP, p. 104; et auctt.
Cellaria Canu and Bassler, 1917, USNMB, 96, p. 33; — 1920, USNMB, 106, p. 272.
Salicornaria auctt.
Farcimia Fleming, 1828, BA, p. 534.
Melicerita Jullien, 1888, CH, p. 67.
Melicerita Jullien and Calvet, 1903, BCH, pp. 46, 127.

Genotype, *Eschara fistulosa*, Linn., 1758, SN, p. 804 (nec *Cellaria fistulosa* auctt.). See Harmer, 1923, JLS, XXXV, p. 301, where the difficult questions of the status of the genus and that of its genotype are discussed.

Typically jointed, but occasionally unjointed, the zooecia usually opening all round the cylindrical internodes, which may, however, be flattened. Body-cavities pear-shaped (text-fig. 13), produced proximally into a narrow, tubular portion, which reaches the distal part of the orifice of the preceding zooecium in the same longitudinal row. Outlines of zooecia hexagonal, pentagonal or lozenge-shaped. Horizontal cryptocyst not definitely marked off from the lateral walls, which are recumbent and usually overlap parts of the adjoining zooecia. Opesia greatly reduced, hardly larger than the orifice, the distal margin semicircular, the convex proximal border formed by a small median process, at the sides of which are a pair of condyles, sometimes accompanied by a second pair of distally situated teeth. Avicularia with undivided opesia, or with opesiules separated from it.

In his Challenger Report Busk (1884, p. 85) divided the species of *Salicornaria* into three Sections, of which the first and third are unjointed. The jointed forms (Articulatae) were further subdivided into two groups, the majority of which, the Nodatae, are characterised by possessing a joint formed of a "knot of intricated radical tubes" and are stated to occur mostly in the Southern Hemisphere. The three jointed Siboga species fall within this group.

As illustrated by *C. punctata* the joints consist of a compact plexus of chitinous tubes, in the curve of the bifurcation, closely applied to the distal end of the parent branch, and to the inner sides of the two daughter-branches. Individual tubes are connected with any two of the participating internodes. The exact way in which they are attached to the calcareous parts is not easily ascertained; but some at least are connected with the frontal surfaces of zooecia. This agrees with the relations of the attaching rootlets found at the base of the colony. In this position a branching rootlet originates from a short tubular projection which springs from the horizontal cryptocyst of a zooecium (see Pl. XXI, fig. 17, and Busk, 1852, BMC, Pl. LXIII, fig. 3). (See also under *C. praelonga*).

Levinsen's statement (1909, p. 211) that "the areas and the zooecia do not correspond in this family", refers merely to a difference in size of the two regions (see also his preliminary paper, 1902, VMNFK, p. 21); and my own account, as given below, does not appear to differ essentially from his conception of the structure of the zooecia. Each of the "areas" enclosed by the raised edges of the zooecia (text-fig. 13,*a*) is the exposed frontal surface of a single zooecium, as is shown by the study of dry material cleaned with eau de Javelle, and even more clearly in decalcified preparations, in which a polypide is seen to correspond with each area. The areas may be lozenge-shaped (Pl. XXI, fig. 14), in which case the two proximal sides meet the distal end of the preceding zooecium in the same longitudinal row, sometimes uniting just as they reach it. In other parts of the internode (text-fig. 13,*a*), these two sides meet at some distance

from the proximal end of the zooecium to which they belong, and the union is prolonged as a median ridge, which may be of considerable length, to the oral arch of the preceding zooecium. Where a median ridge is present the zooecia are hexagonal, the median ridge of one zooecium forming the longitudinal common wall of two alternating zooecia. Hexagonal outlines are characteristic of the ordinary zooecia, in *C. punctata*, and lozenge-shaped outlines of the individuals in the fertile swellings.

The body-cavity has the form of an elongated pear, with a long, cylindrical stalk, as shown in text-fig. 13,*a* [1]). Its narrow, cylindrical end underlies the median ridge of the proximal

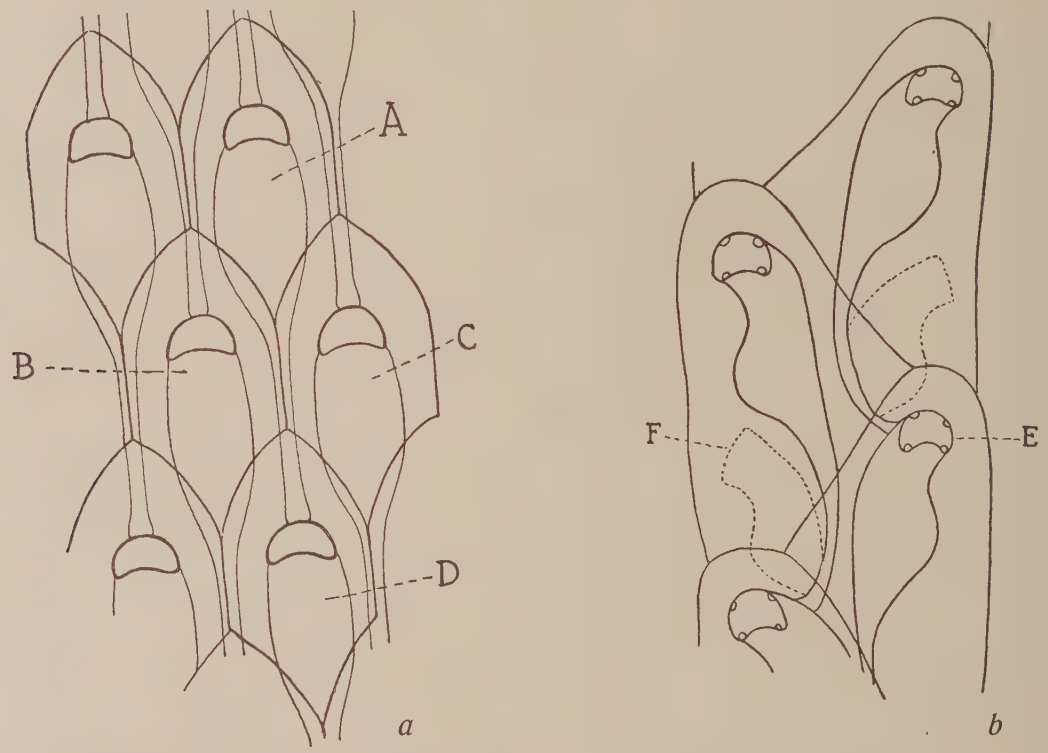

Fig. 13. — Diagram to show the relation of the body-cavities to the surface-areas of the zooecia in *a*, *Cellaria punctata*, and *b*, *C. anceps*. In *a* the body-cavity A is prolonged by a narrow proximal extension to the original distal wall of D, and is followed, in part of its course, by the median ridge formed by the union of the recumbent lateral walls of B and C. In *b* the body-cavities of the zooecia on the distant side of the colony are dotted, the orifices of E and F belonging to two zooecia opening on opposite sides.

end of the zooecium, and is traceable as far as the distal wall of the orifice, where the terminal rosette-plates are situated. The body-cavity is thus considerably longer than the frontal area. The fact that the body-cavity of each zooecium extends as far as the orifice of its predecessor in the same longitudinal row shows that this wall is the original distal wall of the zooecium. The orifice, which in evolution was probably terminal, has become separated from the definitive distal wall by changes accompanied by a distal growth of the cryptocyst, as in the Aspidostomatidae and other Families. The relations of the parts of the zooecia in *Cellaria* seem to be further elucidated by *Atelestozoum obliquum* n. sp. (p. 346).

1) Waters (1888, Chall., Pl. II, fig. 6) shows a similar arrangement in *C. rigida* MacGill., and his figure further illustrates the lateral connexions of zooecia belonging to different longitudinal rows.

Key to the Siboga species of *Cellaria*.

1	Zoarium jointed, the joints of the nodular type. Internodes cylindrical	2.
	Zoarium apparently unjointed, flattened, 4-serial to 6-serial (2 and later 3 series of zooecia on each principal surface)	4. *C. anceps*.
2	Zoarium 4- and 6-serial. Mandible wider than long, subtriangular .	1. *C. punctata*.
	Zoarium 3- or 6-serial	3.
3	Zoarium 3-serial. Frontal surface of zooecia several times as long as wide	3. *C. praelonga*.
	Zoarium 6-serial. Frontal surface of zooecia much less than twice as long as wide. Orifice of ovicell facing proximally	2. *C. tecta*.

1. *Cellaria punctata* (Busk). Pl. XXI, figs 14—16, text-fig. 13, *a*).

Salicornaria punctata (pars) Busk, 1852, VR, p. 366.
Salicornaria gracilis Busk, 1852, BMC, p. 17, Pl. LXIII, fig. 3; Pl. LXV bis, fig. 2. Queensland.
Salicornaria gracilis Busk, 1884, Chall., p. 93, text-fig. 13, A (operculum and mandible). Torres Straits.
Salicornaria gracilis Meissner, 1902, ATIB, p. 730 (name only). Torres Straits.
Salicornaria tenuirostris Haswell (nec Busk), 1880, PQC, p. 36 (avicularia not found). Queensland.
Cellaria gracilis MacGillivray, 1880, PZV, V, p. 50, Pl. XLIX, figs 4—4*c*. Victoria; — 1885, PRSV, XXI, p. 94, Pl. I, fig. 8 (operculum).
Cellaria gracilis Waters, 1887, AMNH, 5, XX, p. 92, Pl. IV, fig. 6. New Guinea, 7 fath.
Cellaria gracilis Kirkpatrick, 1890, TS, p. 611 (name only). Torres Straits.
Cellaria gracilis Marcus, 1922, SAB, p. 19, text-fig. 11. S. Africa.
Cellaria johnsoni Thornely, 1895, PGM, p. 109 (name only). Ceylon.
Cellaria gracilis, var. *tessellata* Waters, 1913, BEA, p. 495, Pl. LXVII, fig. 7 (frontal surface). Zanzibar Channel, 10 fath.
(?) *Cellaria candeana* d'Orbigny, 1851, PFTC, p. 28. Chinese Seas. Stated by WATERS (1905, AMNH, 7, XV, p. 3) to belong to the *Cellaria salicornioides* group.

658. A. Stat. 2. Madura Strait, 56 M.
16. G. Stat. 49a. Sumbawa, E., 69 M.
31. F. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M.
40. A. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
459. I. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
487. C. Stat. 129. Karkaralong Group, S. of Mindanao, 0—31 M.
101. A. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M.
396. B. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
501. A. Stat. 163. Seget, N. end of New Guinea, 29 M.
506. A. Stat. 164. W. of N. end of New Guinea, 32 M.
343. C. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
541. A. Stat. 257. Kei Is, 0—52 M.
185. B. Stat. 258. Kei Is, 0—22 M.
305. A. Stat. 273. Jedan, Aru Is, 13 M.
205. A. Stat. 282. Timor, E. 27—54 M.
222. A. Stat. 305. Solor Strait, E. of Flores, 113 M.
235. A. Stat. 310. Sumbawa, E., 73 M.
374. F. Locality not recorded.

Cambridge, Mus. Zool.: —

Torres Straits, 43, 87, 163, A. C. HADDON, Reg. Feb. 24, 1898.
Singapore, 6 fath., R. HANITSCH, Reg. Apr. 10, 1900.

BM Ceylon, Miss L. R. THORNELY (as *C. johnsoni*), Reg. Apr. 25, 1906.
Queensland, Miss E. C. JELLY, Reg. May 24, 1895.
BM Queensland (W. A. HASWELL Coll.), Australian Museum, Reg. Oct. 23, 1899.
BM Off Tokyo, Japan, 40—80 fath., 5. AF, 11. G, A. OWSTON, Reg. June 23, 1902.

Joints nodular. Internodes delicate, straight, sinuous or curved, reaching a length of 10 mm., but often not more than 3—4 mm.; with one or two succcessive swellings, to which the fertile zooecia are restricted. Zooecia 4- or 6-serial, area hexagonal or lozenge-shaped, with a conspicuous, longitudinal cryptocyst-ridge, on either side, at some distance within the margin. Opesia subcentral, transversely elongate, its lower lip or median process with a pair of strong condyles. Ovicell large, deeply immersed, its orifice largely occupied by a median process which widens distally. Avicularia with a subtriangular opesia, larger than that of the zooecia, its median process generally uniting distally, on either side, with a tooth on the lateral cryptocyst, thus forming a pair of closed opesiules. Mandible with a strong distal spike.

In his British Museum Catalogue (1852, p. 17) BUSK substituted *Salicornaria gracilis* for *S. punctata* of his earlier work (VR, p. 366) of the same year; but, as in other similar cases, he did not explain his reason for the change. Having been unable to discover any valid motive for rejecting the original name, I feel bound to accept it; and I select as the type of *C. punctata* (Busk) the "Rattlesnake" specimen in the British Museum (99. 7. 1. 1578) from Cumberland Islands (Queensland). Although the loss of the familiar name *gracilis* is to be regretted, it is necessary to sacrifice it, on the ground that it is pre-occupied by *Cellaria gracilis* Philippi (1843, Beitr. Kenntn. Tert. Verstein. nordw. Deutschl., p. 38).

In his Challenger Report (1884, p. 86) BUSK referred to *Salicornaria gracilis* Costa, describing it as "a small form from the Adriatic". I cannot find this under *Cellaria* (1842, p. 7) in COSTA's "Fauna del Regno di Napoli", but BUSK may have had in mind *Galaxaura gracilis* Costa (*t. cit.*, Appendix, 1843—1844, Idrofiti, p. 15, Pl. III, figs 1*a*, A, B), a Cellariiform Alga [1]).

Salicornaria tenuirostris Hasw. and *Cellaria johnsoni* Thorn. are included in the synonymy on the evidence of specimens received from the respective original collections.

The zooecia of *C. punctata* are in alternating whorls of four or six, the more slender internodes having the smaller number. Every second whorl then shows two zooecia directed obliquely outwards, on each surface. The alternating whorls have one zooecium seen in face, one on the opposite side of the internode, and one on either side, directed completely outwards. When six zooecia occur, every second whorl shows three zooecia, of which two look obliquely outwards, while the alternating whorls have two zooecia seen in face, one looking directly outwards on each side, and the other two on the distant side. In either case the zooecia are uniformly spaced round the surface of the cylindrical internode. A characteristic feature of this species is the restriction of ovicells to distinct swellings, one or two in a single internode; but this arrangement occurs also in other species, as in *C. nodosa* Norman (1909, JLS, XXX, p. 293) and in *C. wasinensis* Waters (1913, BEA, p. 495).

At the growing points of immature internodes, the outlining ridges of the zooecia are developed *in situ*. The horizontal cryptocyst commences as a calcareous film, proximally and

1) Mr SHERBORN calls my attention to *Salicornaria gracilis* [nom. nudum] Nardo (1847, Prosp. faun. mar. Veneto, p. 23), to which BUSK perhaps meant to refer.

laterally, soon reaching the proximal border of the opesia, beyond which it does not at first extend. The morphologically distal wall is formed, simultaneously with the completion of the proximal part of the horizontal cryptocyst, as a vertical oral arch of appreciable height, and it remains for some time uncovered by the cryptocyst. The curved cryptocyst-ridges appear while the oral arch is developing, at first as thin, delicate laminae, which subsequently thicken. These blend distally with the ridges which form the definitive distal end of the zooecium. For some time they remain, on the distal side of the orifice, in the condition described below in *Atelestozoum*; an oblique layer of cryptocyst becoming applied to, and increasing the original recumbent wall. Between these layers there remains a median depression (fig. 14, upper part), which might be mistaken for a young ovicell, but actually resembles the corresponding part in *Atelestozoum*. In old zooecia the depression becomes filled by cryptocyst, and the part on the distal side of the orifice is then flat or only slightly concave. The original oral arch has by this time become submerged in the thickened cryptocyst, above which its edge hardly projects. The late development of the cryptocyst on the distal side of the original orifice probably represents the secondary extension of the cryptocyst, during evolution, round the distal border of the orifice.

The mature horizontal cryptocyst is finely granulated, on the distal as well as on the proximal side of the orifice, but the other parts of the exposed surface are smooth. The proximal border of the opesia is formed by a median process, depressed on its frontal surface and partially outlined by a projecting edge. Opesiules are represented merely by the outer corners of the opesia, and on their median sides are a pair of strong teeth, compressed proximally, and ending in a wider knob distally, thus forming a fulcrum on which the operculum moves.

Avicularia are not common, but one often occurs at the base of each of the facing surfaces of the younger internodes at a bifurcation, sometimes on one of the branches only. They may occur elsewhere, as in fig. 14. As in the zooecia, the cryptocyst extends far beyond the original oral arch, which forms a projecting hood, subtriangular in frontal view. The proximal border is straight, being formed by the edge of a T-shaped median process, the arms of which are slender and usually meet a pair of teeth formed by the more external part of the cryptocyst. Opesiules are thus, in most cases, completely cut off from the opesia. The proximal horizontal cryptocyst is deeply depressed at its proximal end, thence rising to the free edge of the median process.

The ovicell has been described by Calvet (1900, TIZM, N. S., 8, p. 264) and by Levinsen (1909, p. 65; see also p. 210), who referred it to a type which he termed "endotoichal". He supposed that it originates as a small cavity in the thick frontal wall of the zooecium, its size being subsequently enlarged by resorption of the calcareous matter. This conclusion appears to have been based principally on the evidence of ground longitudinal sections, which I think he misinterpreted.

Young branches in which ovicells are developing at the growing points can be recognised by the characteristic swellings to which these structures are restricted. The separating walls of the young internode are all delicate and thin, and there can be no question of a thick frontal wall in which the cavity of the ovicell could be excavated. The ovicells have their full size from the first, their walls being developed *in situ*, simultaneously with the others which limit the zooecia.

Fig. 14 shows the greater part of a fertile dilatation of an internode. The presence of an ovicell is at once indicated by its characteristic orifice, situated distally to a zooecial orifice and restricted in size by a somewhat T-shaped median process, projecting into it from its proximal border. The ovicell occupies a position which corresponds with that of the median depression found on the distal side of the opesia in incompletely calcified zooecia, and can probably be regarded as having evolved from a space of that nature. Its frontal and lateral walls are seen in fig. 14, which shows that the ovicell is of considerable size. It is completely separated [1]) from the zooecium by a vertical wall, which is the oral arch of the preceding zooecium. Its distal and lateral walls have invaded parts of the three contiguous zooecia, and its fronto-basal diameter is much greater than that of the spaces seen in a corresponding position in incompletely calcified zooecia or avicularia. In these individuals the narrow proximal end of the body-cavity of the next distal zooecium passes on the basal side of the distal median depression. Owing to the depth of the ovicell, the proximal end of the next zooecium has similarly to make a considerable bend round its basal wall, in order to reach the distal wall of the fertile zooecium.

The ovicell of the Aspidostomatidae and of the Cellariidae appears to be morphologically an entozooecial ovicell which has been cut off, by a calcareous septum, from the distal end of a fertile zooecium. This having been accomplished, it has reached a higher morphological level by assuming some of the characters of a zooecium, as shown by the occurrence in it of an independent orifice and operculum, and by the presence of a median process resembling that of the zooecia.

The operculum and mandible of *C. punctata* have been figured by Busk (1884, Chall., p. 93, fig. 13, A), who also shows the depressor sclerites indicated in my fig. 15 (*d. s.*). The operculum is well chitinised [2]), but it has no distinct sclerites. The depressor sclerites extend both proximally and distally to the orifice, which hardly differs from the opesia in size and shape. In 16. G (fig. 15) the proximal, converging ends of these sclerites are connected by a network of chitinous thickenings of the frontal membrane, of the kind described by Waters (1913, BEA, p. 495, Pl. LXVII, fig. 7). These were not found in 40. A, but I have not examined decalcified preparations of other specimens. Their purpose may be to distribute the strain of the depressor muscles (which I have not observed satisfactorily) over the frontal membrane; and the unusual distal extension of the depressor sclerites may have the same purpose.

The mandible, which is somewhat foreshortened in fig. 16, is subtriangular, with basal and marginal sclerites; and its thin median region has a small fenestra, or thinner part of the chitin. It bears a single, strong, distal spike, as figured by Busk (*l. c.*, right hand figure). The polypides are small and delicate and possess 12 tentacles in the cases in which I have been able to make a satisfactory count.

2. *Cellaria tecta* [3]) n. sp. (Pl. XXI, figs 10, 11, 17—20).

95.A. Stat. 122. N. of Menado, N. Celebes, 1165——1264 M. One colony.

Joints nodular. Internodes moderately stout, reaching a diameter of ·8 mm. and a length

1) Calvet (*l. cit.*) stated that its cavity is continuous with that of the zooecium.

2) Levinsen (1902, VMNFK, p. 7) and Calvet and Bassler (1920, USNMB, 106, p. 272) state that the operculum is bilaminar. I think this is probably correct, the chitinised layer being the inner one, as in the Aspidostomatidae.

3) *tectus*, roofed; in allusion to the covered orifice of the ovicell.

of 13 mm.; straight or slightly sinuous, curved at the base in such a way as to form bifurcations shaped like tuning forks. Zooecia 6-serial, usually in distinct longitudinal rows, and then pentagonal with the distal angle rounded. Opesia near the distal end, with a small median process and a pair of strong proximal teeth. Proximal horizontal portion of the cryptocyst occupying the greater part of the frontal surface; deeply depressed, outlined by a pair of curved ridges, with rounded edges, usually dying away before reaching the distal end. Fertile zooecia in inconspicuous swellings, of which there may be as many as three in an internode. Ovicells with an orifice facing proximally and greatly reduced by a large median process. Avicularia without median process, the rostrum not much raised, narrow and acute distally. Mandible triangular, broad at the base, acutely angular distally.

The basal members of the colony give off numerous rootlets, formed as in *C. punctata*, running along the surface of the stem and uniting to form a bundle of fibres for attachment. In these basal zooecia the opesia is often occluded by calcareous matter. The units of the colony are arranged in alternating whorls of three, one of which may be an avicularium. In the fertile portions all three zooecia of a whorl bear ovicells. The zooecia are usually in obvious longitudinal rows, each reaching its predecessor in the same row. Some lateral overlap of the zooecia may be indicated by the formation of a short median ridge on the proximal end of the frontal surface of a zooecium.

The opesia is much nearer the distal end than in *C. punctata*, and the proximal cryptocyst is correspondingly longer. The opening is relatively long, its arch very slightly raised, its median process with a raised lip, evenly rounded and rather narrow. The teeth for the articulation of the operculum are specially strong and are somewhat compressed. All parts of the cryptocyst, including the ridges and the portions external to them, are covered with numerous pearly granules.

The avicularia differ greatly from those of *C. punctata* in shape and in the form of the opesia, which is oval, sometimes with a pointed arch distally. There is no trace of a median process, nor are opesiules present. The edge of the rostrum is sharply bent inwards proximally, on each side, forming a condyle for the articulation of the mandible. The proximal horizontal cryptocyst resembles that of the zooecia, but the floor of the rostrum is thin and smooth.

The ovicells (fig. 20, *ov.*) are prominent, their distal part forming a projecting hood, which is thick, granulated and white, and is mainly formed by the cryptocyst of the next zooecium. Ovicells of a somewhat similar type have been figured by Waters (1904, BB, p. 37, Pl. II, fig. 12) in *C. dubia*. The orifice is directed completely proximally, so that in a frontal view it lies in a vertically transverse plane. It is reduced to a crescentic slit by the very strong median process (*m. p.*), and the actual opening is so narrow that the escape of the larva would appear to be possible only by a great constriction of its tissues. The shape of the cavity of the ovicell has not been ascertained, owing to the thickness of the cryptocyst. It probably resembles that of *C. punctata*, as in fractured branches it is seen to extend almost to the axis of the internode. Between the ovicell and the axis is a narrow perforation (in a transverse section); and this is no doubt the proximal part of the next distal body-cavity, as described above in *C. punctata*.

The opercula (figs 10, 11) are relatively long, somewhat exceeding the opesia in size. The proximal border, which is strongly concave, has a deep cavity, on each side, for the

reception of the condyles. Each side gives off a triangular flange (fig. 11), of the usual Membraniporine character, for the insertion of the occlusor tendon. The muscle which seems to represent the depressor and the divaricator is near the occlusor, but its fibres run more proximally, the tendon apparently passing into the frontal membrane immediately on the proximal side of the mandible. A united pair of sclerites, on the inner sides of the calcareous ridges, are arranged as a pointed arch enclosing the operculum, but seem not to be connected directly with any muscle.

The mandible (figs 18, 19) is broadly triangular at its base, but becomes narrow distally, the pointed end being gently curved and acute. The basal sclerite has a median proximal projection, as in *Aspidostoma* (Pl. XXII, fig. 3), and into this is inserted the tendon of two small muscles. The parts of the sclerite in contact with the transverse condyles of the avicularium are deep vertical laminae. The occlusors are powerful and fill most of the avicularian cavity.

3. *Cellaria praelonga* [1]) n. sp. (Pl. XXI, figs 27—30; text-fig. 14).

153.B. Stat. 211. S. of Celebes, 1158 M. Probably three colonies.

Joints nodular. Zoarium delicate, well branched, attached by a basal bundle of rootlets. Internodes cylindrical, reaching a length of 10 mm., curved at the base, so that the bifurcation resembles a tuning fork, the rest nearly straight. Zooecia triserial, the frontal areas of any two in the same longitudinal row widely separated, but united by an elongate median ridge; the area hexagonal, with long lateral sides; about four times as long as wide. Proximal cryptocyst convex, except at the base of the median process, where it is slightly depressed. Cryptocyst-ridges wanting. Opesia very near the distal end, from which it is separated by a deep depression; its entire border much raised. A pair of proximal teeth inside the opesia. Avicularium replacing a zooecium, with the hexagonal area much shorter than in the zooecia; the rostrum a narrow, elongate triangle, without median process; a proximal part of the opesia separated from the larger distal part by a constriction formed by the condyles. Mandible terminating in an acute spike. Ovicells not found.

Fig. 14. — *Cellaria praelonga*. Zoarium (153.B[1]), natural size.

This striking species is characterised by its extraordinarily long and narrow triserial zooecia, which bear the orifice almost at the distal end. The rootlets which form the basal tuft are given off, as in other species, from a large number of the lower zooecia (fig. 29), the uppermost of which are at a considerable distance from the attenuated base of the calcareous parts. Each rootlet applies itself closely to the outer surface of the internode, running longitudinally down the colony and being joined by other rootlets, similarly situated. They pass beyond the proximal zooecia and form a cylindrical bundle of closely applied fibres, which soon reaches the ooze, and then by repeated divisions gives rise to a tangle of very fine rootlets, which are attached to Foraminifera.

The joints, which are of the „nodate" or nodular type, can be examined readily in this delicate species. The longitudinal ridge separating the two basal zooecia of a young internode, on the inner side of a bifurcation, is prolonged into a projecting, thickened flange (fig. 28), which at its free proximal end bears several apertures (fig. 30), from which chitinous tubes issue.

1) In allusion to the extremely elongated zooecia.

A similar calcareous thickening, giving rise to joint-fibres, is found at the distal end of the parent internode, in its median portion. The tubes issuing from these three thickenings form a chitinous tangle in the concavity of the bifurcation. The actual joints are formed by resorption of an annular region of the calcareous walls of the zooecia at the bifurcation, as is usual in *Cellaria* (Cf. Waters, 1881, QJGS, XXXVII, p. 320; — 1887, AMNH, 5, XX, p. 92; — Lomas, 1889, PBSL, III, p. 219; — Pergens, 1890, BSBG, III, Mém., p. 313; — Stewart, 1900, CRCS, p. 55).

Canada balsam preparations show that the body-cavity passes, as in other species, beneath the median ridge separating two zooecia, as far as the orifice of the next proximal zooecium. The entire length of the zooecium seen in face, above the avicularium, in fig. 30 is thus between 1.5 and 1.6 mm. The cryptocyst is considerably thickened, so that the transverse diameter of the body-cavity beneath the hexagonal area is much less than that of the zooecium. The arrangement of the body-cavities is like that shown in text-fig. 13 (p. 336). The surface of the cryptocyst is smooth in the younger zooecia, but in the older condition it bears a number of widely spaced, slightly acute granulations. The horizontal cryptocyst is traversed by a median suture.

The whole margin of the zooecium is much raised, the oral arch being prominent, and the lower lip, or median process, also projecting above the general surface. Owing to the projection of the outlining ridges, the frontal membrane is separated from the cryptocyst by a distinct hypostegia.

The avicularia (fig. 30) resemble the zooecia in outline but are much shorter as regards their hexagonal area. An individual of this kind commonly occurs, as in other species, on the inner side of the base of an internode, facing the opposite side of the bifurcation. The opesia is undivided and is of the type found in *C. tecta*. The rostrum is triangular, long and narrow, with a distinct oral floor, and its tip reaches the distal end of the avicularium. The mandible no doubt resembles the rostrum in form, but I have not been able to examine it in frontal view. In side view (fig. 27) it is seen to terminate in an acute spike.

4. *Cellaria anceps* [1]) n. sp. (Pl. XXI, fig. 21, text-fig. 13, *b*, p. 336).

499. D. Stat. 161. W. of N. end of New Guinea, 798 M.

Zoarium small, unbranched, attached by a delicate flexible tube. Stem much attenuated below, commencing with a pair of zooecia, becoming flattened and biserial on each principal surface and afterwards 6-serial (3 on each surface), with sharp lateral edges. Zooecia in distinct longitudinal rows, the median ones hexagonal, with rounded distal angles, the remainder with only one (the inner) lateral angle. Cryptocyst nearly flat, without longitudinal ridges, covered everywhere by pearly granulations. Orifice near the distal end, with two proximal and two distal teeth. Avicularia not found. Ovicells solitary, borne by a median zooecium, the orifice very wide and crescentic.

The 4-serial part of the zoarium has a considerable resemblance to a Victorian Tertiary fossil described by Maplestone (1900, PRSV, XIII, p. 1) as *C. biseriata*; in which, however, only two teeth were found in the opesia.

This species is represented by three minute colonies, respectively 8, 4 and 2 mm. long.

1) *anceps*, two-edged, in allusion to the form of the zoarium.

The largest bears two ovicells, one on each of the flattened surfaces, and it may thus be regarded as more or less mature. Each of the two smaller colonies has the frontal membrane covering its two basal zooecia prolonged into a delicate, cylindrical, membranous tube, of the same diameter as that of their attenuated proximal ends, and 3—4 mm. long. The tube, which has been lost in the largest colony, is obviously a means of attachment to the muddy sand, in which it was presumably completely embedded. This mode of attachment seems to be similar to that found in *Kinetoskias* and *Parmularia*. Neither branches nor joints are present, nor were avicularia found.

The colony begins with a pair of zooecia, placed back to back, but with their orifices near one edge of the stem. It becomes definitely biserial (on each surface) and slightly curved, but is now broader, one zooecium opening on one surface of the branch (text-fig. 13, *b*, E) and the other at the same level on the opposite surface (F). So long as the stem is 4-serial, the zooecia are asymmetrical, the outer edge of each being straight, the inner edge with a marked angle. The distal three fifths of the largest colony is 6-serial (fig. 21), the edges of this part being quite straight, but a slight bend being present at its commencement. The distal part in particular is broad and flattened, the median region the thickest, the edges sharp. Each whorl consists of one symmetrical, median zooecium, and two lateral zooecia, on the opposite side of the stem. The lateral zooecia are asymmetrical, like all the zooecia of the 4-serial region.

The horizontal cryptocyst is continuous with the more lateral parts, which are so oblique as to be nearly in the same plane as the horizontal portion. The median process is not prominent, but it has a depression, as usual, on its frontal surface. The rest of the cryptocyst is almost flat, and the oral arch is hardly raised. The proximal teeth of the orifice are associated with the movements of the operculum, but the distal pair are probably merely stops, to prevent this structure from being drawn in too far by the contraction of the occlusors. In the fertile zooecium the two distal teeth are connected by a curved ridge (fig. 21), which is just indicated in some of the ordinary zooecia. These two teeth, with their connecting ridge, may be regarded as representing the oral shelf of other genera (*Cf.* Waters, 1904, BB, p. 35).

The cryptocyst is considerably thickened, and the body-cavities are thus not nearly so large as the frontal surfaces of the zooecia, (text-fig. 13, *b*). The cavity is dilated on the proximal side of the orifice, and then rapidly diminishes in diameter proximally, becoming a narrow tube which passes near the axis of the stem, curving round the basal surface of the next zooecium on the opposite surface, and reaching the original distal wall of the next zooecium of its own row.

The ovicell (fig. 21) is large, as seen in the Canada balsam preparation, and has the same structure as in *C. punctata*. Its orifice is very wide and short, its size being reduced by the projection into it of a large median process with a concave distal border, slightly denticulated laterally. The membrane closing the orifice has a chitinised distal margin. One of the ovicells contains a large egg or embryo. The other is empty, but a large egg occurs in the body-cavity of the fertile zooecium.

The cryptocyst seems to originate from separate centres of calcification, which are most easily seen in the lateral parts. They correspond, in appearance and arrangement, with those described below in *Atelestozoum*. The median zooecia have a median suture running along the horizontal cryptocyst.

2. Atelestozoum [1]) gen. nov.

Zoarium free, the zooecia opening principally on two opposite faces. Zooecia with a depressed horizontal cryptocyst, of considerable extent, its distal lobes prolonged round the border of the orifice without completely uniting on its distal side. Vertical walls much raised, their edges marking off large, angular areas which occupy the entire surface. Opesia and orifice practically co-extensive, widely separated from the distal end of the area, with a raised oral arch and a distinct median process. Avicularia and ovicells unknown. Genotype, *A. obliquum* n. sp.

1. *Atelestozoum obliquum* n. sp. (Pl. XVI, fig. 21).

526. E. Stat. 211. S. of Celebes, 1158 M.

Characters as in the genus. Zoarium compressed, apparently unjointed. Zooecia large, opening mostly on the flat surfaces, in alternating whorls of two or three on each face. Area large, hexagonal, the lateral sides the longest. Horizontal cryptocyst about three fifths the length of the area, slightly convex, smooth, imperforate. Frontal parts of the walls of the zooecia sharply separated from the edge of the horizontal cryptocyst, and sloping obliquely [2]) outwards. The cryptocyst passes round the orifice, widening distally, but its two lobes unite incompletely, leaving a triangular interval between them, just distally to the oral arch. This interval is the uncovered part of the proximal end of the zooecium of the same row, the area of which is found in the whorl next but one distally. Orifice and opesia more or less crescentic, the median process with a frontal depression, the oral arch somewhat raised and semicircular.

The material consists of a single straight fragment, 8 mm. long. At its proximal end, which is incomplete, the transverse diameter is ·6 mm. It widens distally, there reaching a diameter of 1 mm. The lowest whorl of zooecia consists of four individuals, one opening on each of the two principal faces, the other two on the lateral surfaces. The next whorl, also of four, has two zooecia on each principal face. The third whorl resembles the first, while the fourth has two zooecia on each face and one on one of the sides. The fifth and sixth whorls are of five zooecia; on one face respectively two and three, and on the opposite face three and two (fig. 21, which shows the sixth and seventh). The seventh and eighth (the last) whorls have three zooecia on each face. The areas of the zooecia are alternate in consecutive whorls but do not represent the total length of the zooecium, which extends as a narrow proximal portion, underlying two zooecia of the preceding whorl, and reaching the oral arch of the next zooecium of its own longitudinal row. The hexagonal area is about 1.1 mm. long, and the total length of the zooecium is about 1.9 mm.

In the zooecia which are not marginal the horizontal cryptocyst is smooth and glossy, while the obliquely vertical walls which rise from its edges are traversed by transverse, wavy lines which appear to indicate the occurrence of separate centres of calcification. These probably point to the deposition of a secondary layer of cryptocyst on the original walls. In the marginal zooecia the outer wall seems to be extended inwards over the horizontal cryptocyst, as far as a

1) *ἀτέλεστος*, unfinished, in allusion to the incomplete union of the distal lobes of the cryptocyst.
2) Hence the trivial name.

longitudinal line which meets the distal side of the oral arch or the median process. The wavy lines above described are present in this extension. The original walls pass beyond the orifice, becoming much wider, and the prolongations of cryptocyst which line them unite in a median distal suture but do not meet basally. In the marginal zooecia the greater part of the region situated distally to the orifice is formed by the outer wall.

The operculum is delicate, wider than long, and it possesses a weak main sclerite which is almost marginal.

Although there is no evidence of the existence of avicularia and ovicells in this genus, *Atelestozoum* seems to belong to the Cellariidae and to give instructive information with regard to the meaning of some of the peculiar features of the Family. The zoarium resembles some conditions of *Cellaria* in having its frontal surface constituted entirely by angulated areas which by no means represent the entire extent of the zooecia. As may occur in that genus (text-fig. 13, *a*) the proximal part of each zooecium is entirely concealed by the apposition of the lateral walls of two zooecia of the preceding whorl. A frontal view (Pl. XVI, fig. 21) shows, on the distal side of the oral arch, a small triangular region which represents the proximal end of the succeeding zooecium in the same longitudinal row. The horizontal cryptocyst is deeply depressed and sharply marked off from the moderately oblique lateral walls, and its prolongations do not completely unite on the distal side of the oral arch. In certain parts of *Cellaria punctata* (text-fig. 13, *a*, p. 336) the proximal ends of the zooecia are completely invisible in frontal view, although they are represented in the figure as seen through the overlying calcified parts. The prolongations of the cryptocyst have completely united on the distal side of the oral arch, which is thus far removed from the distal end of the area. The frontal parts of the lateral walls are recumbent, having become so oblique as to be nearly horizontal, and they have become continuous with, and hardly distinguishable from, the original horizontal cryptocyst. In certain other species of *Cellaria* (see HINCKS, 1880, BMP, Pl. XIII), as is indeed the case in parts of *C. punctata*, the zooecia retain a more primitive arrangement in longitudinal rows.

3. Syringotrema [1] gen. nov.

Zoarium free, cylindrical, unjointed, attached by chitinous rootlets. Zooecia with lozenge-shaped or pentagonal areas, bounded by raised walls. Cryptocyst convex and little depressed proximally, produced round the distal border of the orifice, which is far removed from the distal end of the area. Opesia and orifice almost co-extensive, surrounded proximally and laterally by a cryptocyst-ridge within which is a complete, nearly vertical, calcareous tube terminating in the orifice. Avicularia vicarious. Ovicells with a distal hood, on the proximal side of which are two lateral flaps or auricles. Genotype, *S. auriculatum* n. sp.

1. *Syringotrema auriculatum* n. sp. (Pl. XXI, figs 22—26; text-fig. 15).

Type. 6. A. Stat. 12. S. of Kangeang Id, 289 M.
156. C. Stat. 211. S. of Celebes, 1158 M.

Characters as in the genus. Zoarium composed of narrow dichotomous branches, the

1) σῦριγξ, a tube; τρῆμα, a hole; in allusion to the form of the peculiar calcareous tube.

zooecia arranged in alternating whorls of three or two. A single avicularium, with wide, triangular mandible, at each bifurcation. Ovicells large and conspicuous.

It is noteworthy that three of the interesting new species of Cellariidae here described were obtained at Stat. 211.

The zoarium (text-fig. 15) consists of delicate, cylindrical branches, just reaching 1 mm. in diameter. It bifurcates from time to time, the greatest distance measured between two bifurcations being 8 mm. The branches are slightly curved inwards at a bifurcation. The zooecia, which open all round the branch, have pentagonal or lozenge-shaped areas in alternating whorls of three, or of two placed back to back, in which case the arrangement is decussate. Pl. XXI, fig. 23 shows both lozenge-shaped and pentagonal zooecia, the distal end being rounded in the latter case and the proximal acute angle being prolonged as a median ridge, as in certain conditions of *Cellaria*. The imperforate cryptocyst is convex in the proximal part of the zooecium and bears numerous small granulations. On the distal side of the orifice is a depressed, concave region, outlined by the lateral parts of a cryptocyst-ridge, the proximal part of which forms a prominent lip, denticulate and usually produced into a distinct point at one end. The lateral parts of the ridge merge distally into the external bounding wall of the area. In this depressed region, which resembles the young state of a hyperstomial ovicell, the proximal zooecium overlaps its distal successor. Two longitudinal lines seen in its floor are the walls separating the narrow proximal end of the next distal zooecium from two zooecia of the adjacent whorl. The arrangement is in fact substantially the same as in *Cellaria* (text-fig. 13, *a*, p. 336). From the study of Canada balsam preparations I conclude that the whole floor of the concave region is formed by the prolongation of the cryptocyst of the overlapping zooecium, and is not merely part of a common wall separating it from its neighbours

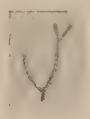

Fig. 15. *Syringotrema auriculatum.* Zoarium (6. A[1]), natural size.

At the proximal end of the region bounded by the cryptocyst-ridge is a short, subvertical, calcareous tube, which is closed by the operculum and is probably constituted by the union of the oral arch distally and the free border of the cryptocyst proximally. It is thus not comparable with the calcareous tube of *Steganoporella*, which is derived from the cryptocyst. The arrangement of the opercular and depressor muscles has not been observed with certainty, but I believe that their tendons pass through the tube. Muscles certainly exist laterally in the zooecium, on the proximal side of the tube, towards which their fibres are directed. It is significant that the operculum may be partially withdrawn into the mouth of the tube; and this could hardly happen if the occlusor muscles did not pass through it.

The avicularia (fig. 23) are vicarious, and are outlined by a prominent ridge, enclosing an area, within which is a nearly flat cryptocyst. From this rises, excentrically and nearer the proximal end, a circular or oval ridge, most raised distally, where it forms the rostrum. The proximal part of the ridge is semicircular and surrounds a depressed part of the cryptocyst, which slopes rather steeply down to the undivided opesia. This lies in an obliquely vertical plane, depressed proximally and sloping up to the distal margin of the rostrum. On each side of it is a condyle for the articulation of the mandible. The avicularium reaches the edge of the branch, in the concavity of the bifurcation, on one side only; and in fig. 23 the long straight edge of the avicularium is part of the edge of the bifurcation.

The ovicell (fig. 26) has a highly characteristic structure. It is developed in the part corresponding with the depressed region on the distal side of the orifice in an ordinary zooecium. Its distal part is a projecting hood, and the lateral parts are two large lobes or auricles (hence the trivial name) of the cryptocyst. These meet to a greater or less extent in the middle line, but apparently always leave a triangular opening, not closed by calcareous substance, just below the distal hood. Below one of the ovicells the operculum of the zooecium is seen in the mouth of the calcareous tube.

The opercula (fig. 22) are much wider than long. The main sclerite is distant from the margin and runs for the most part transversely, bending proximally at each end, and giving off a small triangular flange at each of the two bends thus formed, on the deep side. These are no doubt for the insertion of the occlusors. The proximal edge is nearly straight and there is no basal sclerite. The mandible (fig. 25) is subtriangular, considerably wider than long. The area of thin chitin enclosed by the two halves of the main sclerite is large and there is a strong basal sclerite. At its distal border the mandible bears three short but strong teeth. The tentacles are about 20.

In Canada balsam preparations the young zooecia (fig. 24) are seen to be elongated and tubular, becoming narrow proximally. Their calcareous wall, which is entirely covered by a frontal membrane, is apparently composed of a pair of large calcifications, separated by a median suture. As the zooecium grows it gives rise to lateral wings, which enclose the area. These are continuous with the part of the cryptocyst which passes round the distal border of the orifice; and the ridge surrounding this opening is early developed, being formed in the first instance as a distally directed lower lip. By the growth of the distal cryptocyst the orifice assumes an almost central position in the area, while the development of the wings greatly alters the superficial pattern of the zooecia. The wings and the distal concave region are formed of a number of separate centres of calcification, as in *Atelestozoum*; and these give rise to elongated, narrow platelets, passing transversely across the entire width of the wings, and radially round the orifice in the distal concave region (*Cf.* Levinsen, 1909, MSSB, p. 4).

Syringotrema should probably be placed in the Cellariidae, in the neighbourhood of *Atelestozoum*. It resembles the species of this Family described above in the form of the body-cavity and of the area, and in the shifting of the orifice in a proximal direction by the union of lobes of the cryptocyst on the distal side of the oral arch. The ovicell has moreover an independent opening on the distal side of the orifice, as in *Cellaria*, although having special characters of its own.

Division 5. Cellularina.

Cellularina (pars) Smitt, 1867, KVAF, XXIV, p. 279.

Fam 1. Scrupocellariidae.

Scrupocellariidae Levinsen, 1909, MSSB, pp. 89, 130.
Scrupocellariidae Canu and Bassler, 1920, USNMB, 106, p. 180.
Cellulariidae (pars) auctt.

See Levinsen for the distinguishing features. The habit is erect and unilaminar; the zoarium being attached by rootlets and in most species having a biserial arrangement of the

zooecia. A very characteristic feature is the presence of a specially modified spine, the scutum or fornix, jointed at its base, widening or branching towards its free end, and projecting horizontally over the opesia; but this structure is not infrequently wanting, often only in certain individuals of a colony. The heterozooecia are adventitious, acute, and not jointed at the base; showing a high degree of specialisation in their occurrence on three distinct regions of a single zooecium; — on the proximal part of the frontal surface (paired or unpaired), on the outer distal corner of a marginal zooecium, and on the basal surface, where they may be avicularia or vibracula. Like the scuta, any one or more of the heterozooecia typically present may be wanting.

1. **Amastigia** Busk.

Amastigia Busk, 1852, BMC, p. 40.
Amastigia Harmer, 1923, JLS, XXXV, pp. 298, 329.
Caberiella Levinsen, 1909, MSSB, pp. 134, 135.
Anderssonia [1]) Kluge, 1914, BDSE, p. 617.
Monotypical. Genotype, *A. nuda* Busk, 1852.

In the paper cited I have given a diagnosis of this genus, with reasons for believing that it includes many of the species which have been referred to other genera of the Scrupocellariidae. The Siboga Collection contains one of these species, usually described as *Caberea rudis*. In this, as in *A. crassimarginata* (Busk) (1884, Chall., p. 28), the rootlets given off by the vibracula form a marginal bundle running down each side of the branch (a characteristic, but not a distinctive feature of the genus), instead of passing along the keel formed in the middle line of the basal surface by the strongly developed vibracula, as in *Caberea* (*s. str.*). While in *Caberea* the heterozooecia usually cover the whole of the basal surface, in *Amastigia* they leave a considerable part of that surface exposed; and they are of special interest, in the present genus, in being avicularia, vibraculoid avicularia or vibracula. The branch is usually pluriserial and is flat or even concave basally, without a median keel, the heterozooecia of that surface not coming into complete lateral contact with one another. I have given reasons for regarding *Amastigia* as a central genus of Scrupocellariidae, some of its species showing a distinct approach to other genera of the Family. *Amastigia* is not usually jointed, but *A. kirkpatricki* (Lev. MSS.) Harmer (1923, p. 335) is as well jointed as *Scrupocellaria*.

1. *Amastigia rudis* (Busk). (Pl. XXIII, figs 9—13).

Caberea rudis Busk, 1852, VR, p. 377. Bass Straits; — 1852, BMC, p. 38, Pl. XLVI, figs 1—3 (nec Busk, 1884, Chall., p. 30).
Cabarea (errorim) *rudis* Haswell, 1880, PLSNSW, V, p. 36. Holborn Id, Queensland (no description).
Caberea rudis MacGillivray, 1887, PZV, XIV, p. 137, Pl. CXXXVI, figs 1—1*b*. Victoria.
Carberea (errorim) *rudis* Ortmann, 1889, ANG, LVI, 1, p. 23, Pl. I, figs 8*a*, *b*. Japan, 200 fath.
Caberea rudis Yanagi and Okada, 1918, AZJ, IX, p. 419. Japan, 2—80 fath.
Menipea marginata Hincks, 1884, AMNH, 5, XIV, p. 276, Pl. IX, figs 1—1*d*. Victoria. (Referred to *C. rudis* by Hincks, 1893, AMNH, 6, XII, p. 143).
Amastigia rudis Harmer, 1923, JLS, XXXV, p. 332, Pl. XVII, figs 26, 27; Pl. XIX, figs 49, 52.

1) Pre-occupied: see Harmer, 1923, p. 298.

459. D. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
101. F. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M.
183. A. Stat. 260. Kei Is, 90 M.
209. B. Stat. 285. Timor, E., S. coast, 34 M.

Cambridge, Mus. Zool.: —

Queensland, Miss E. C. JELLY, Reg. May 24, 1895.
Queensland, from W. A. HASWELL's Collection (undetermined material), Australian Museum, Reg. Oct. 23, 1899.
BM Japan, 2. R, 5. AB, 18. C, 28. A, 49. J, 25—80 fath., A. OWSTON, Reg. June 23, 1902.

Multiserial, the branches composed of 5—10 series of zooecia, bordered by lateral bundles of rootlets arising from the vibracula, a few passing round the axils. Cryptocyst broad, its inner margin descending into the body-cavity. A conspicuous oral shelf, frequently with two depressions, corresponds with the overlap of the succeeding zooecium. External spines 3—4 (marginal zooecia) or 2—3 (median zooecia); inner spines 1 or 2. Frontal avicularia paired on the median zooecia, their mandibles directed obliquely proximally except on the distal side of an ovicell, where, as in other Scrupocellariidae, their direction is reversed (fig. 10). On the marginal, and occasionally on the submarginal zooecia, a single frontal avicularium may be conspicuously enlarged or even gigantic. Marginal avicularia (fig. 12, *m. av.*) small, inconspicuous, often on the basal surface, and invisible in frontal view. Setae of the vibracula, or basal heterozooecia, smaller than in *Caberea* and without lateral branches. Basal surfaces of median zooecia lozenge-shaped, convex, their widest parts overlapping the proximal ends of their lateral neighbours (HARMER, 1923, Pl. XVII, fig. 27). Scutum variable, linear to orbicular, arising near the distal end of the opesia, its cavity narrow. Ovicells large, the ectooecium extending to the frontal surface only as a narrow band, distally and laterally.

The general appearance of this species is different from that typical of *Caberea*, the branches being broad and spreading, instead of narrow and with parallel edges; — a fact which is not without significance with regard to its generic position.

A. rudis is known to extend from Victoria, through Queensland to Japan, where it is obviously common. BUSK (1852, BMC) described the spines as 3—1 [1]) on the marginal zooecia and 1—1 on the others. YANAGI and OKADA found 4 or 3 external and 2 internal on the marginal zooecia and 2—2 on the others. The Siboga specimens usually have 3—1 spines on the marginal zooecia, but there are 3 or 4 external spines in 101. F. The median zooecia may have 2—1 spines (the smaller number on the side of the scutum), but some have 2—2, or even 3—2; and I have found a similar variability in Japanese specimens. The scutum (figs 9, 11) is very variable. It may be as figured by BUSK, with an expanded blade having a distinct distal lobe (459. D), but in 183. A it is linear and directed obliquely proximally, the distal lobe being suppressed. A similar linear scutum occurs in one of the Japanese specimens (2. R), but in another (28. A) it is large and orbicular, filling nearly the whole of the opesia. Other Japanese specimens show a variable condition of the scutum in the same colony, connecting these extremes. The cavity of the scutum generally remains nearly linear, though often dilating near the middle and at the end.

1) The first number represents the external spines. See fig. 11.

The single frontal avicularium of the marginal zooecia (fig. 10) may be enlarged, and the edges of the rostrum then show a minute serration. The tip of the rostrum is nearly always hooked or aquiline, and the mandible (fig. 13) has a strongly incurved apical spike. These features are less developed in the avicularia of the median zooecia.

The vibracula (fig. 12) vary much in size, but not greatly in shape. They have a strong, narrow, tooth-like process overhanging the base of the seta, which is smooth or destitute of serration (fig. 13). This is the condition originally described by BUSK, who stated, however, in his Challenger Report (1884, p. 30) that this account was erroneous. The British Museum possesses two slides (87. 12. 9. 143 and 99. 7. 1. 894), referred to this species, from the Challenger Station 161, Port Phillip, Victoria, but they are certainly wrongly determined, the vibracula projecting beyond the margins of the branches, to which they form a serrated edge. This is never the case in *A. rudis*, in which the vibracula are completely on the basal surface and are invisible in frontal view. I believe the Challenger specimens to belong to *Caberea grandis* Hincks (1881, AMNH, 5, VIII, p. 2), a species in which the seta is serrated. Although MACGILLIVRAY described a slight serration in Victorian specimens, I venture to think that this requires confirmation.

The original figures given by BUSK are not altogether satisfactory; and MACGILLIVRAY's fig. 1*a* gives a much better idea of the type-specimen (54. 11. 15. 82)[1]) than do BUSK's own figures. The very large frontal avicularia of the type are swollen and aquiline, as represented by MACGILLIVRAY from his own material; and this is the condition I have usually found. These avicularia are subject, however, to some variation, and the hooked beak of the rostrum may be almost or quite suppressed. In one of the Japanese specimens included in my list there are no conspicuously enlarged frontal avicularia, a condition which YANAGI and OKADA have distinguished as var. *minor*.

2. **Notoplites** [2]) Harm.

Notoplites Harmer, 1923, JLS, XXXV, p. 348.
Cellularia, Menipea and *Scrupocellaria* (partim) auctt.
Genotype, *N. rostratus* Harmer, 1923, p. 349.

Zoarium jointed, the branches biserial. Zooecia elongate, the opesia not occupying a large proportion of the front and the operculum very slightly differentiated. Bifurcation as in Pl. XXIII, fig. 16, one or both branches jointed, the joints passing on the distal sides of the zooecia C and D [3]), without traversing the opesia of either an inner or an outer zooecium; F and G with long proximal segments, in contact with one another on the basal side of E; proximal segments of J and K very short. Basal avicularia, approaching a vibraculoid form, typically present, and then usually confined to the bifurcations. Rootlets given off by these and from the proximal ends of the zooecia, on the distal side of a joint, in most cases closely applied to the margins of the branches or passing round the axils at the bifurcations. Scutum, frontal and marginal avicularia present or wanting. Ovicells typically large and with a frontal fenestra.

1) The British Museum also possesses a good unmounted specimen (BUSK Coll., 99. 7. 1. 6587) from the original 'RATTLESNAKE' Collection, labelled Bass Straits, 45 fath., Feb. 10, 1848.

2) *νῶτον*, back; *ὁπλίτης*, an armed man; in allusion to the basal avicularia.

3) The notation of the zooecia is as explained in my 1923 paper (p. 322) and as used in text-fig. 23, under *Bugula*, and in other places in this Report. A is the first zooecium, preceding a bifurcation, which gives rise to two distal successors.

I have proposed this genus, which approaches *Amastigia* in the characters of its basal heterozooecia, primarily for a group of deep water species found by the Siboga; and to them the entire diagnosis applies. These species have the habit common in deep water forms; — the colony being supported by a common stalk composed of parallel rootlets, which diverge at their proximal end to form a tuft for attachment to the ooze. Except in *N. obliquidens*, basal avicularia occur, of vibraculoid form, provided with a rootlet-foramen, and giving off a rootlet. In all of them the rootlets are arranged as a pair of marginal groups, or closely applied to the axils at the bifurcations, which are thus strengthened. The type-species possesses a scutum, as well as marginal and frontal avicularia, and may be considered to represent the genus with its full complement of characters. In *N. scutatus* frontal avicularia are wanting; in *N. impar* the scutum as well; and in *N. obliquidens* the scutum, marginal and basal avicularia are absent. The genus thus shows a tendency, noticeable in *Scrupocellaria* and others, for important characters to fail to appear. In the paper cited I have called attention to the importance of the method of bifurcation and jointing as a generic character.

Key to the Siboga species of *Notoplites*.

1	Scutum present. Basal avicularia on both branches at a bifurcation	2
	Scutum wanting. Basal avicularia present or wanting	3
2	Scutum lobed, partially covering the opesia Basal avicularia directed distally	1. *N. rostratus.*
	Scutum entire, oval, truncated distally, completely covering the opesia. Basal avicularia directed obliquely proximally	2. *N. scutatus.*
3	Frontal avicularia wanting. One branch jointed and bearing a basal avicularium	3. *N. impar.*
	Frontal avicularia present, erect. Both branches jointed. Basal avicularia not found	4. *N. obliquidens.*

1. *Notoplites rostratus* Harm. (Pl. XXIII, figs 14—17).

Notoplites rostratus [1]) Harmer, 1923, JLS, XXXV, p. 349.

526. C. Stat. 211. S. of Celebes, 1158 M. Two colonies.

Zoarium reaching a length of 55 mm., the main stem about 20 mm. long, composed of parallel rootlets. Rootlets arising from the sides of the zooecia, near their proximal ends, and running down the margins of the branches; and, distally to the bifurcations, from basal vibraculoid avicularia. Zooecia long and narrow, their outer outline concave. Opesia occupying much less than half the front, oval, reduced by a broad, crescentic cryptocyst, larger in fertile zooecia. Distal spines 2 external, 1 median and 1 internal, with a fifth arising from the basal surface; jointed at the base. Scutum similarly jointed, strong, usually bilobed, the distal lobe smaller and generally acutely pointed; both lobes often shortly bifurcate. Ovicells extremely long, imperforate except for a transversely elongate fenestra on the frontal surface, near the orifice. Frontal

1) In allusion to the strongly beaked gigantic avicularia.

avicularia on the inner side, at some distance from the opesia, variable in size, those of the ordinary zooecia elevated, reclining against the orifice of the preceding alternate zooecium, towards which the rostrum is directed, the linear mandible lying distally, and when closed sloping obliquely inwards, distally and frontally. Frontal avicularium of a zooecium succeeding an ovicell gigantic, directed nearly transversely across the ovicell, the rostrum proximal and the linear mandible distal. Marginal avicularia variable in size, usually relatively small, directed outwards and obliquely basally and proximally, occurring just on the proximal side of the outer spines. Marginal avicularia of fertile zooecia, and sometimes of the zooecium next preceding an ovicell, gigantic, originating slightly on the basal side and directed distally, more or less parallel to the side of the branch, the distal part free, the rostrum with its back to the edge of the branch and the mandible on the outer side. Basal avicularia (one pair) on the inner zooecia of a bifurcation, each giving off a rootlet which runs to the axil or beyond, closely attached to the margin of the branch.

In the form of the scutum and of the ovicell, this species resembles *N. biloba* (Busk) (see HARMER, 1923, p. 350) from deep water off the Azores.

The scutum (fig. 15) is variable in form, but is usually bilobed, both lobes being often shortly branched and its cavity being small. The avicularia are of special interest. While the frontal and marginal avicularia are arranged substantially as in *Scrupocellaria*, the gigantic forms resemble the pedunculate avicularia characteristic of *Bugula*, since, although not articulated, they are largely free, and are not far from having a stalked base. Although the marginal avicularia, when gigantic, are directed distally in the fertile branches (figs 15, 17), they may stand out nearly at right angles in parts where no ovicells are present. The avicularia have no complete calcareous bar dividing the opesia, and the mandibles are acute and linear, those of the small ones being very narrow (fig. 15) and those of the gigantic ones wider (fig. 14). All are provided with a terminal spike. The modified basal avicularia of the zooecia F and G, at a bifurcation (fig. 16), are of special interest. While having otherwise the characters of normal avicularia they produce a rootlet, as in *Amastigia*, and accordingly resemble vibracula.

The rootlet of the avicularium on the zooecium F (fig. 16) extends just beyond the middle of the axil. That of the avicularium belonging to G passes outside the other, running up the opposite branch as far as the avicularium of F, where it terminates. The cavities of the two rootlets are perhaps connected in the axil. The bifurcation may be further strengthened by a rootlet developed from a more distal zooecium, and lying externally to the other two. A joint is formed across G and its lateral neighbour (K), just distally to the end of C, and does not pass through either opesia; and similarly in the other branch.

A small ovary occurs, in the fertile zooecia, close to the basal and inner walls, in the distal half of the zooecium; a position in which I have found the ovary in *Scrupocellaria*.

2. *Notoplites scutatus* [1]) n. sp. (Pl. XXIII, figs 18—20).

Type. 499.A. Stat. 161. W. of N. end of New Guinea, 798 M.
628.A. Stat. 295. S. of W. Timor, 2050 M.
262.G. Stat. 319. Java Sea, 82 M. Fragments.

1) Referring to the highly developed scutum.

Zoarium and rootlets as in *N. rostratus*. Zooecia long and narrow, their outer outline concave. Opesia oval, occupying much less than half the front, with a narrow, finely beaded, proximal and lateral cryptocyst, slightly larger in the fertile zooecia. Spines 6, jointed at the base and some very long; 1 median distal, 1 on the basal side of this, 1 internal and 3 external, of which the third stands nearly vertically and interlocks at its base with the outer edge of the scutum. Scutum jointed at the base, completely filling the opesia, its distal lobe truncate, its cavity complicated. Ovicells very long, imperforate except for a small, asymmetrical frontal fenestra, near the orifice. Frontal avicularia not found. Marginal avicularia projecting outwards, of moderate size, the rostrum strongly hooked; not enlarged in the fertile branches. Basal avicularia on many of the inner zooecia, with a rostrum becoming linear at the tip, directed obliquely transversely and proximally; giving off a rootlet at an acute angle with the avicularium. Bifurcation and joints as in *N. rostratus*.

The zoarium reaches a length of 52 mm., its main stem being about 15 mm. long. *N. scutatus* resembles *N. rostratus* in general appearance, but differs from it in the form of the scutum, in the absence of frontal avicularia, in the shape of the marginal avicularia, none of which are gigantic, and in the greater profusion of the basal avicularia.

The cryptocyst is narrow and beaded, and the whole opesia is filled by the characteristic scutum, which is convex on its frontal surface and is locked in position by the base of the proximal outer spine. The scutum resembles that of *N. marsupiatus* (Jull.) (see HARMER, 1923, JLS, XXXV, p. 351), but is developed on the distal side of its stalk as well as on the proximal side, while in that species the stalk is attached to the inner distal corner of the blade. The basal avicularia, which are longer in 628. A than in fig. 20, are not restricted to the two inner zooecia immediately succeeding a bifurcation, but (particularly in 628. A) are found on a considerable proportion of the zooecia which lie on the inner side with regard to the preceding bifurcation. The rootlet is not given off as a prolongation of the main axis of the avicularium as in *N. rostratus*, but at a sharp angle with it. The rootlets thus formed in the neighbourhood of a bifurcation pass round the axil as in *N. rostratus*. The ovicell (fig. 19) differs from that of the Bicellariellidae in having a much smaller development of its ectooecium, which commences at the point where the ovicell begins to project beyond the rest of the branch. The median part of its basal surface is thus adnate to the branch, and in this respect it agrees with *N. rostratus*. In both species the two layers of the ovicell are in close contact with one another. The fertile branches appear broader than the others, owing to the presence of ovicells, and they usually consist of a much larger number of zooecia (as many as 20 at least), nearly all of which bear ovicells.

262. G. was represented merely by minute fragments, just sufficient for determination, owing to the presence of scutum and basal avicularia.

3. *Notoplites impar* [1]) n. sp. (Pl. XXIV, figs 11, 12).

114. B. Stat. 159. W. of Salawatti, N. end of New Guinea, 411 M. One colony.

Zoarium and rootlets as in the two preceding species, but each main branch forms a unilateral sympode. Zooecia long and narrow, their outer outline concave. Opesia oval, occupying

1) Referring to the restriction of the joint and of the basal avicularium to one side, at the bifurcation.

much less than half the front, with a narrow cryptocyst. Spines 7, jointed at the base; — 1 median distal, 2 internal, 3 external, parallel to one another, and 1, erect, on the proximal side of these. Scutum wanting. Ovicells extremely long and narrow, imperforate except for a very asymmetrical fenestra, on the outer side of the frontal surface, near the orifice. Frontal avicularia not found. Marginal avicularia small, none enlarged. Basal avicularia confined to one of the branches formed at a bifurcation, commencing on the inner margin and directed transversely towards the outer side, the rostrum and mandible greatly attenuated and bent distally. The proximal part of these avicularia is at right angles to the palatal surface, and is prolonged into a rootlet which follows the inner margin of the branch as far as the axil. Bifurcation as in the other species, but only one of the branches jointed.

N. impar, which is represented by a single colony 37 mm. long, is distinguished from its allies by the complete absence of a scutum, and by the characters of the basal avicularia, which are confined to a single branch, the only one jointed, at the bifurcation (figs 11, 12). These avicularia are borne by the zooecium G, and the joint occurs on the same side as the zooecium A. The sympodial branching is very characteristic. The unjointed branches are all on one side, but in two adjacent sympodes they may face one another. The colony is not sufficiently complete, however, to show the entire plan of its branching.

The spines are incomplete, but may possibly reach a considerable length. The marginal avicularia are small and are only present in zooecia with a reduced number of external spines; the full number, as in other species, not always being developed. There is only a single ovicell (fig. 12). The basal wall of the zooecium has a large fenestra, or two fenestrae, due to imperfect calcification (fig. 11).

4. *Notoplites obliquidens* [1]) n. sp. (Pl. XXIII, figs 21—24).

156. B. Stat. 211. S. of Celebes, 1158 M. One colony.

Zoarium as in the preceding species. Rootlets arising from the outer sides of the zooecia, near their proximal ends, and forming a strong group running round the axils. Basal avicularia not found. Zooecia very long and narrow, curving outwards as they begin to expand, their outer margin then remaining nearly straight. Opesia elongate, ovoid, but with nearly straight lateral margins, not much narrower proximally; occupying less than half the frontal length; its margin raised distally and laterally, its proximal end with a narrow cryptocyst. Proximal zooecia with a series of about 7—8 spines. Some of the zooecia near the distal end retain nearly the full number, which is commonly reduced to four, and sometimes to a single external spine. Marginal avicularia wanting. Frontal avicularia originating in the middle line, at a short distance from the opesia, erect, with a hooked rostrum and a very oblique palatal surface. Ovicells not found. Both branches at a bifurcation jointed, but the figured specimen (fig. 24) does not show the distal ends of C and D, beyond which the joints should occur. The specimen is not in good condition, but there seems to be sufficient evidence that, in the older parts, the joints occupy positions corresponding exactly with those shown in fig. 16 (*N. rostratus*).

The single colony is imperfect and is about 17 mm. long. In the region of the rather

1) Referring to the obliquity of the rostrum of the frontal avicularia.

delicate common stalk there are several single zooecia, one of which is continuous proximally with a delicate rootlet contributing to the formation of the stalk. These zooecia (fig. 23) bear 7—8 spines. Rootlets are given off freely from many of the zooecia, and pass proximally in the usual way. These always assume a definite relation to the axils. In the distal part of the colony a single rootlet runs round the axil (fig. 24). More proximally the number increases, so that the most proximal axil is strengthened by four rootlets, closely applied to one another in the plane of the bifurcation. On the outer side, in this region, the outer rootlets, which throughout retain a marginal position, converge to form the common stem, which consists at first of 7 rootlets, to which others are added by the contributions of the single zooecia above noticed. The stem ultimately forms a basal tuft, as in the other species.

The avicularia (fig. 21), which resemble those of *Kinetoskias* in form, have been broken at the base, as shown in the figure. On the analogy of other species this may be considered a fracture and not a joint. Although basal avicularia have not been found it is possible that they might be discovered in more plentiful material.

3. Tricellaria Flem.

Tricellaria Fleming, 1828, BA, p. 540.
Cellarina (pars) Van Beneden, 1848, BARB, XV, 1, p. 70; nec *Cellarina* D'Orbigny, 1851, PFTC, p. 181.
Ternicellaria D'Orbigny, 1851, PFTC, pp. 40, 47.
Bugulopsis Verrill, 1880, PUSNM, II, p. 190.
Tricellaria Harmer, 1923, JLS, XXXV, pp. 317, 353.
Cellularia (pars) and *Menipea* (pars) auctt.
Monotypical. Genotype, *Cellaria ternata* Ellis and Solander, 1786, NHZ, p. 30.

For diagnosis see HARMER, 1923, p. 353. Distinguished from *Notoplites* by the mode of bifurcation and jointing. The branches are biserial and the joints traverse the proximal ends of the zooecia CG and DF, or of one of these pairs in cases (text-fig. 16) where one branch only is jointed. The proximal segments of F and G (or of one only of these zooecia) are short and are usually distant from one another on the basal side of E; and those of C and D (or of one only of these zooecia) are long. Rootlets are given off on the proximal sides of the joints. The reverse conditions are found in *Notoplites*. Basal heterozooecia do not occur.

1. *Tricellaria aquilina* [1]) n. sp. (Pl. XXIV, figs 1, 2, 6; text-fig. 16).

536. A. Stat. 227. Banda Sea, S. of W. end of Ceram, 2081 M. One colony.

Zoarium attached to Foraminiferal ooze by a bundle of parallel rootlets, which are rarely bifurcate in the basal tuft. Rootlets arising from the outer sides of the zooecia, on the proximal side of a joint, and running down the margins of the branches. Zooecia long, narrow proximally, wider distally, their outer outline straight or concave. Opesia regularly oval, or narrower proximally, occupying half the front or less, with a narrow cryptocyst. Spines 3, jointed at the base, not all developed on the same zooecium. A single median distal spine, arising basally, commonly present, and sometimes long; if absent, generally represented by a fenestra on the

1) Referring to the large, aquiline, frontal avicularia.

wall of the zooecium. A single long spine rarely developed on the outer distal margin. An enormously elongated spine, as long as six zooecia, on the inner distal margin of the zooecium B at the bifurcations. Frontal avicularia nearly always present in the middle line, commencing not far from the proximal border of the opesia, the head elongate and swollen, sharply marked off from the narrow rostrum, which is directed proximally and projects freely; the palatal surface on the frontal side, the back of the rostrum reclining on the branch. Marginal avicularia (Pl. XXIV, fig. 1) occasionally found on fertile zooecia, originating on the basal surface, externally, close to the ovicell, the rostrum directed proximally along the outer margin of the branch; in size and structure agreeing with the frontal avicularia. Avicularia without calcareous bar. Ramification sympodial, the internode which takes part in the formation of the main axis jointed at its base, the other half of the bifurcation unjointed. Zooecia F and G widely separated on E. Ovicells elongate, with a conspicuous frontal fenestra reaching the margin of the orifice, otherwise imperforate; the ect- and ent-ooecial layers distinctly separated.

In its mode of branching this remarkable species resembles *Menipea sympodia* Yanagi and Okada (1918, AZJ, IX, p. 410). It seems to be related to this species, from which it differs in the form of the frontal and marginal avicularia and in the fact that the zooecia F and G are not in contact with one another proximally.

The zoarium reaches a length of about 30 mm. and its branching is illustrated by text-fig. 16. The lowest member (A^1) in the figure gives rise to C^1 and E^1, the latter an axillary zooecium. B^1 produces the enormous inner spine (Pl. XXIV, fig. 6) and has one distal successor (D^1). E^1 (text-fig. 16) produces two zooecia, F^1 and G^1, which are widely separated proximally (Pl. XXIV, fig. 2) and form the commencement of the inner series of zooecia of the branches. The branch corresponding with A^1 continues to form zooecia and curves outwards, but is not jointed at its base. A joint is formed, in the other branch, across D^1 and F^1, which thus become the proximal members of the next internode and may be lettered alternatively as A^2 and B^2. The process is then repeated, in exactly the same way, A^2 lying on the opposite side of the stem to A^1, the second joint (J^2) being produced on the opposite side of the sympode, and the elongate, unjointed internode curving outwards in the direction opposite to that of the first branch.

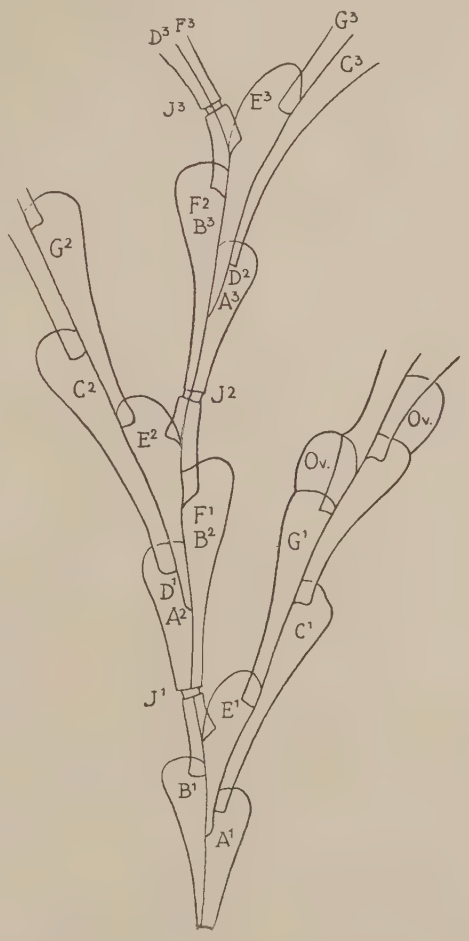

Fig. 16. — *Tricellaria aquilina*. Diagram of bifurcations (536. A.1). For explanation see text.

The unjointed sections of the colony, each consisting of three zooecia which take part in the formation of the main axis and of others forming the lateral branch, are formed by as many as 12—13 zooecia; but as the growth is not complete it cannot be ascertained how many

more might have been formed, or whether these lateral branches, which include a number of ovicells, would have bifurcated. It is probably correct to regard the axis as consisting of internodes of three zooecia (as in most species of *Tricellaria*), each continuous with a terminal internode of 9—10 zooecia, not divided from the axial section by a joint.

2. *Tricellaria scalariformis* [1]) n. sp. (Pl. XXIV, figs 3, 4).

? 478. E. Stat. 107. Sulu Archipelago, 270 M. On slide 478. C², *Catenicella* sp.
Type. 112. I. Stat. 156. W. of Waigeu Id, 469 M. One colony.

Zoarium attached by a stalk composed of parallel rootlets, which bifurcate several times at the basal tuft. Rootlets arising on the outer side of a zooecium, on the proximal side of a joint, running down the basal and marginal surfaces. Zooecia long, not much broader distally, their outer outline slightly curved. Opesia small, oval or narrower proximally, much less than half the frontal length in the distal zooecia, the cryptocyst barely indicated. Spines wanting, but apparently at least 1 distally, on the basal side. Scutum wanting, but probably indicated by its basal articulation. Avicularia and ovicells wanting. Axis of colony sympodial, as in *T. aquilina*, the portions forming the sympode consisting of three zooecia, the successive groups of three continued alternately on the two sides into long straight branches, in which the zooecia are longer than in the main axis. The two zooecia F and G are in contact proximally. Chitinous joints extremely long and strong, the cavity of each tube constricted in the middle, the portions covered by the calcareous walls of the zooecia arranged en échelon.

In the general construction of the colony, which reaches a length of 25—30 mm., this species agrees with *T. aquilina*, but it differs from that species in its smaller opesia, in the absence of frontal avicularia, in the lateral contact of the proximal ends of the zooecia F and G, and by the very different chitinous joints. It is unfortunately in poor condition, having lost its spines and probably its scuta. The main axis is slightly zigzag, the successive components of the sympode being directed alternately to right and left. In a single case a chitinous joint is formed across each of the two branches at a bifurcation; but in other instances only one joint occurs. Many of the zooecia bear a projection, usually in the form of a diverticulum open to the opesia, in the normal position of a scutum, and I assume that this structure was present. The joints are extremely strong, a large exposure of chitin being visible, and the cavity of each tube being here constricted by the thickening of the chitinous wall. This part shows no lamination of the chitin, but the parts of the tubes inside the calcareous walls of the zooecia are obviously en échelon, as shown in fig. 4. This arrangement, which occurs also in *Scrupocellaria*, is not found in *T. aquilina*. The lateral contact of F and G is shown in fig. 3.

478. E, a very young colony, consisting of the ancestrula and five zooecia, may be noted here. It resembles the specimen described above in the proportions of its zooecia, which have several long spines, jointed at the base, and a rather large, oval scutum. On one of the zooecia there appears to be an incompletely developed frontal avicularium. The single joint shows two scalariform markings at its distal end. This is possibly a young condition of the present species.

1) Referring to the ladder-like appearance of the joints.

4. Caberea Lamx.

Caberea Lamouroux, 1816, PCF, p. 128.
Selbia Gray, 1843, DNZ, p. 292.
Flabellaria (pars) Gray, 1848, BMRA, pp. 106, 146.
Caberea Hincks, 1880, BMP, p. 57; et auctt.
Genolectotype, *Caberea dichotoma* Lamx, 1816, p. 130, Pl. II, figs a, *B*, *C* (see Harmer, 1923, JLS, XXXV, p. 300).

Zoarium not regularly jointed, biserial to pluriserial. Zooecia relatively short, the opesia occupying most of the frontal surface. Spines usually inconspicuous except in the young condition. Scutum present or wanting. Frontal avicularia paired or single, the rostrum directed proximally, except on the distal side of an ovicell, where the direction is reversed; like the marginal avicularia, usually small or minute; in certain species enlarged. Vibracula very large, in a double series on the basal side, directed obliquely proximally and covering the greater part of the basal surface, where they form a conspicuous median keel. Setae typically serrate, but occasionally simple, a condition which may occur in zooecia at the proximal end of the colony in species in which the seta is serrate in the zooecia of fully developed branches. Rootlets, given off by the vibracula, pass down the basal surface at the summit of the keel formed by the vibracula. Ovicells relatively short.

It seems impossible to recognise *C. dichotoma*, the genotype, a pluriserial species, without reference to Lamouroux' type-specimens if they still exist. Busk (1852, VR, p. 378) gave it as a doubtful synonym of *C. lata*. It is to be noted that Lamouroux (p. 129) described *Caberea* as reaching a length of 4 to 6 decimetres, but on the next page the length of one of his species is given, no doubt more correctly, as 7—8 centimetres.

Caberea is related by its vibracula to *Scrupocellaria*, from which it is distinguished by having these structures much larger and by its typically unjointed character. The setae reach a size which is rarely found in Polyzoa; and, as shown by Hincks (1878, QJMS, XVIII, p. 8) they exhibit an exceptional peculiarity in being co-ordinated in their movements, in a British species at least. It is unknown how far this is of general occurrence, but it may be noted that Goldstein (1880, JMSV, I, p. 47), in describing the movements of the setae in *C. lata*, makes no mention of co-ordination. The eggs are described by this author as being bright scarlet in colour. The muscles of the vibracula have been described by Jullien (1888, CH, p. 75, Pl. XIII, fig. 5).

In correlation with the high development of the vibracula, the avicularia of *Caberea* are often very small. This is specially the case with the marginal avicularia, which may be enlarged, however, in some specimens of *C. lata*. Some of the frontal avicularia, in certain species, are greatly enlarged, or even gigantic. I believe the mandibles to be invariably pointed, in opposition to the statement of Busk (1884, Chall., p. 27).

The zoarium is commonly described as being unjointed, but this is not altogether correct. Busk stated (1884, p. 28) that the zoarium is really jointed, although only one of the members of the bifurcation is thus provided, an arrangement which I have found in *C. lata*. Waters describes and figures articulations in this species (1887, AMNH, 5, XX, p. 84, Pl. IV, fig, 4; — 1913, BEA, p. 474). But although joints may occur, they are not so constantly present as in other genera; and I think they may sometimes be secondary; i. e., that they may not be produced

simultaneously with the bifurcation, but later, perhaps as a fracture, accompanied by the development of chitinous connecting tubes.

Marcus (1921, BJFI, p. 98, fig. 1*b*), shows an ancestrula, of an elongate flask-like shape, bearing about 8 very long spines; the next two zooecia having each 4 long spines, resembling those of the ancestrula. Maplestone (1882, PRSV, XVIII, p. 50) stated that 16 tentacles are present, in two species.

Key to the Siboga species of *Caberea*.

1 { Scutum wanting. Branches usually 4-serial except in young colonies . . 1. *C. lata*.
{ Scutum present. Branches biserial 2

2 { Zoarium delicate. Scutum entirely filling the opesia . . . . . 2. *C. boryi*.
{ Zoarium robust in the adult condition. Scutum transverse, not entirely filling the opesia . . . . . 3. *C. transversa*.

1. *Caberea lata* Busk. (Pl. XXIV, figs 7—9).

Caberea lata Busk, 1852, VR, p. 378. Off Cumberland Is (Queensland) 27 fath.; — 1852, BMC, p. 39, Pl. XLVII, figs 1—3; — 1884, Chall., p. 30, Pl. XI, figs 3, 3*a*. Stat. 186, Torres Straits; Stat. 190, S. of New Guinea.
Caberea lata Waters, 1887, AMNH, 5, XX, p. 84, Pl. IV, fig. 4 (joints).
Caberea lata Kirkpatrick, 1890, AMNH, 6, V, p. 16 (o), Tizard Bank, China Sea; — 1880, TS, p. 611 (o). Torres Straits.
Caberea lata Philipps, 1899, WZR, pp. 439, 441 (o). Lifu, Loyalty Is, 17 fath.
Caberea lata Meissner, 1902, ATIB, p. 730 (o). Amboina.
Caberea lata Thornely, 1907, MPIM, p. 183 (o). Gaspar Straits (Malay Archipelago).
Caberea lata Yanagi and Okada, 1918, AZJ, p. 418. Japan, 54—312 fath.
Caberea lata Robertson, 1921, BBB, p. 36 (o). E. of Madras Presidency, 24—30 fath.
Caberea lata Marcus, 1922, AI, p. 424. Aru Is.
Cabarea (errorim) lata Haswell, 1880, PQC, p. 36. (o). Holborn Id, Queensland, 20 fath.
Carberea (errorim) lata Ortmann, 1889, ANG, LVI, 1, p. 22, Pl. I, figs 5*a*—*c*. Japan, 60—200 fath.
Caberea lata, var. *tsushimensis* Okada, 1923, AZJ, X, p. 221, Plate, figs 12—14. Corea.

o) signifies no description.

380. B. Stat. 47. Bima, Sumbawa, N., 55 M.
611. A. Stat. 60. Haingsisi, Samau Id, W. Timor, 0—36 M.
337. E. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
43. E. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
459. N. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
396. H, K. / 598. D. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
501. C. Stat. 163. Seget, N. end of New Guinea, 29 M.
127. A. Stat. 164. W. of N. end of New Guinea, 32 M.
445. A. Stat. 181. Ambon, 36—54 M.
344. C. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
194. B. Stat. 274. Off Jedan, Aru Is, 57 M.
214. B. Stat. 299. Rotti Id, S., S.W. of Timor, 0—34 M.
226. A. Stat. 305. Solor Strait, E. of Flores, 113 M.
242. B. / 242. D. Stat. 310. Sumbawa, E., 73 M.

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Queensland, W. A. HASWELL Coll. (unsorted), Australian Museum, Reg. Oct. 23, 1899.
New Guinea, S. of, Challenger Coll., Stat. 190, 45 fath., Reg. Nov. 18, 1899.
Torres Straits, Challenger Coll., Stat. 186, 8 fath. Reg. Nov. 18, 1899.
Torres Straits, 12, 86, A. C. HADDON, Reg. Feb. 24, 1898.
BM Lifu, Loyalty Is, 17 fath., A. WILLEY (Miss PHILIPPS), Reg. May 1, 1898.
BM Japan, 6. A, 50 fath., A. OWSTON, Reg. June 23, 1902.
Japan, T. MITZOBUCHI, Reg. Feb. 1, 1901.

C. lata occurs from Queensland to Japan and the Indian Ocean. It is also recorded by Miss PHILIPPS from the Loyalty Is, but is not included by MACGILLIVRAY in his Catalogue (1887, PRSV, XXIII, p. 200) of the Polyzoa of Victoria.

Young colonies delicate, mostly biserial; older colonies robust, usually 4-serial. Frontal surface of branches flat, basal surface moderately carinate, owing to the arrangement of the vibracula. Cryptocyst well developed, sloping down to the body-cavity, the oral shelf moderately distinct. Distal spines 1—1, long in the young condition (fig. 7), the external spine the stronger; short or vestigial in old zooecia. Scutum wanting. Frontal avicularia small, either one or two on the proximal side of the opesia. Marginal avicularia lying on the frontal surface of the vibracula, near their distal ends, usually minute, sometimes considerably enlarged, projecting laterally, with a swollen proximal surface, the rostrum and mandible short and wide, the mandible with a strong vertical terminal spike. Vibracula strong, with an elongate groove, crossed near the articulation of the seta by the usual calcareous bridge, the outer lobe of the proximal end (the end distally situated) of the rostrum forming a broad tooth projecting at the edge of the branch. Seta (fig. 9) strong and long, its proximal part flattened, its distal half bearing a unilateral series of strong serrations, which are wanting or vestigial in young colonies. Ovicells short, with a conspicuous, curved, frontal fenestra not covered by the ectooecium.

Some of the colonies have a purplish colour (in spirit), but I have been unable to detect any other differences between them and others of a yellowish colour. The young, biserial colonies are much more delicate than the robust, older specimens, from which they differ much in appearance. A colony may reach a considerable size without becoming more than triserial. Enlarged marginal avicularia have been noticed by BUSK (1884, pp. 30, 31, Pl. XI, fig. 3*a*); and occur in the specimens in the above list from Torres Straits (Challenger and A. C. HADDON, 12) and in the Siboga specimen 194. B. In colonies thus provided the lateral margins of the branches show an additional series of serrations, due to the enlarged avicularia alternating with the projecting ends of the vibracula. In nearly all the specimens I have examined, the full number of longitudinal series of zooecia is 4 (fig. 8), but BUSK (1852, BMC, Pl. XLVII, fig. 2) figured a 5—6-serial branch, and stated in his original account (1852, VR) that it is 4—7-serial, with 2—5 rows of central cells, an arrangement shown by a slide (99. 7. 1. 874) from BUSK's type-material ('Rattlesnake') from Cumberland Is. This shows a difference between the marginal and median zooecia, as described by BUSK, who exaggerated its importance, as it is hardly more noticeable than in other species. The avicularia are very minute and often wanting, in this specimen, which accordingly has a smooth appearance. In this respect and in its large number of longitudinal rows of zooecia, the specimen seems to be exceptional. In another 'Rattlesnake' specimen (99. 7. 1. 6585, unmounted), from 15 fath., off Cape Capricorn, not far from the type-

locality, the branches are 4-serial, and the avicularia are much larger, giving a rough appearance to the frontal surface of the branch.

The figure given by WATERS (1887, Pl. IV, fig. 4) shows both branches at a bifurcation as jointed. In the 4-serial colonies I have myself examined, there is a difference between the two branches, one being biserial at its origin and the other, which may be regarded as the continuation of the main branch, being triserial, owing to the intercalation of an additional row starting from the axillary zooecium. The branches which have a biserial origin are given off alternately on opposite sides of the parent branch. Each biserial branch quickly becomes 4-serial, its first biserial offshoot being on the side which is external with reference to the preceding bifurcation. The branch which commences in the biserial condition seems to be usually jointed at its base.

2. *Caberea boryi* Aud. (Pl. XXIV, figs 13—15).

Crisia boryi Audouin, 1826, EPS, p. 242; — 1828, p. 73. Barcelona, Corsica, Alexandria. Cellaires, Savigny, DE, Pl. XII, figs 4^1—4^6.
Caberea boryi (*C. zelanica*) (pars) Busk, 1852, BMC, p. 38, Pl. XVI, figs 4, 5. Cumberland Is (Queensland).
Caberea boryi Busk, 1860, QJMS, VIII, p. 281 (no description). Madeira.
Caberea boryi Heller, 1867, VZBGW, XVII, p. 89. Adriatic.
Caberea boryi Waters, 1879, AMNH, 5, III, p. 280 (no description). Naples.
(?) *Caberea boryi* (pars) Hincks, 1880, BMP, p. 61, Pl. VIII, figs. 9—11.
Caberea boryi Waters, 1885, JRMS, 2, V, Pl. XIV, figs 9, 10, 15 (mandibles and operculum); — (pars?), 1887, AMNH, 5, XX, p. 89; — 1897, JLS, XXVI, p. 9.
Caberea boryi Thornely, 1912, PIOS, p. 140. Cargados, Indian Ocean. 30 fath.
Caberea boryi Canu and Bassler, 1925, MSNM, X, p. 17. Morocco (Atlantic).
Caberea darwinii auctt. (nec Busk, 1884, Chall., p. 29).
Carberea (errorim) minima Ortmann, 1889, ANG, LVI, 1, p. 23, Pl. I, figs 9*a*, *b*. Japan (nec *Caberea minima* Busk, 1884, Chall., p. 30).

423. A. Stat. 181. Ambon, 0—54 M.

Cambridge, Mus. Zool.: —

BM Japan, 4. L, 50 fath., A. OWSTON, Reg. June 23, 1902.

The above list contains a selection of references to descriptions nominally of *C. boryi*, but I do not feel certain that all the synonyms are correct. It is probable that more than one species is included under this name.

Zoarium very delicate, the branches biserial, keeled basally. Cryptocyst broad, especially proximally, thin, not sloping down to the body-cavity, the opesia much reduced, completely separated from the orifice, which is nearly semicircular, somewhat oblique, filled by a well chitinised operculum, and without a distinct oral shelf. Spines 1 or 2 external, 1 internal, found in young zooecia but difficult to distinguish in the others. Scutum (fig. 13) with a very broad stalk, originating distally, its distal lobe forming the proximal border of the orifice, terminating in a point and closely connected with a calcareous lobe from the outer side of the zooecium, completing the separation of the opesia from the orifice. Proximal lobe of the scutum rounded, completely filling the opesia, with the exception of a crescentic slit. Frontal avicularium single, on the inner side. Many of the frontal avicularia are greatly enlarged (fig. 14), much inflated and with a

hooked rostrum, the mandible triangular, hardly longer than wide, and terminating in a strong vertical spike. Marginal avicularia minute, situated on the vibracula, opposite the orifice. Vibracula not covering the whole basal surface, the setal groove crossed by a bridge (fig. 15), at a lower level than the edges of the groove, at the articulation, on the outer side of which is a prominent, broad tooth. Seta strong in proportion to the size of the colony, broadened at the base, particularly in the axillary vibraculum, and with few, rather distant serrations along one edge. Ovicells slightly globose, usually with a transverse fenestra near the orifice.

The form from Japan recorded by ORTMANN as *C. minima* agrees with a specimen from the same locality in the Cambridge Collection. It can hardly be referred to *C. minima* Busk, from the Falkland Is, a species with a very different scutum. The Siboga specimen has a scutum resembling SAVIGNY's fig. 4^6 of *C. boryi*, and this is the principal justification for referring it to his species. It differs, on the other hand, from his fig. 4^4, which may have belonged to another species. British specimens referred to *C. boryi* which I have examined have a much larger seta than the Siboga specimen, while the scutum does not fill the opesia to the same extent.

MARCUS (1921, BJFI, p. 96; — BAC, p. 90), under *C. darwinii*, discusses at some length the differences between this species and *C. boryi*; coming to the conclusion that *C. darwinii* occurs in the Antarctic, Subantarctic, Japanese and probably Tropical regions, while *C. boryi* is found in the Mediterranean and in the non-polar parts of the Atlantic. *C. boryi*, as I understand it, seems to be distinguishable principally by the characters of the scutum, which unites with the opposite wall of the zooecium in such a way as to separate the orifice from the rest of the opesia, as noticed by HELLER, HINCKS and WATERS (1887, 1897). The scutum lies almost in the opesia, but in *C. darwinii* it is raised above it, its free border not lying in the same plane as the edge of that opening.

A few of the frontal avicularia are greatly enlarged in many specimens referred to *C. boryi*, as noticed by WATERS (1897, Mediterranean, Brittany) and by Miss THORNELY (Indian Ocean); and I have myself found them in specimens, in the British Museum, from British and Mediterranean localities. This character is not distinctive, however, as enlarged frontal avicularia also occur in specimens of *C. darwinii* from Nightingale Id, Tristan da Cunha (Challenger); and to this species the Australian specimens with this character mentioned by HINCKS (1880) and WATERS (1897) may perhaps have belonged.

In view of these considerations I am inclined to conclude that *C. boryi* occurs in the Mediterranean (the type-locality), the Indian Ocean, the Malay Archipelago and off Japan. Its occurrence off the south coast of Australia seems to require confirmation, and I do not feel confident that it includes the British species.

3. *Caberea transversa* [1]) n. sp. (Pl. XXIV, figs 5, 10).

20. G. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
37. L. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
605. A. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
75. A. Stat. 105. Sulu Archipelago, 275 M.
92. G. Stat. 117. Kwandang Bay, N. Celebes, 80 M.
108. N. Stat. 144. S. of Halmaheira (Djilolo), 45 M.

1) In allusion to the direction of the scutum.

396. I. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
150. C. Stat. 204. Between Wowoni and Buton, S. E. Celebes, 75—94 M.
376. H. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
218. B. Stat. 301. Rotti Id, E., S.W. of Timor, 0—45 M.
228. A. Stat. 305. Solor Strait, E. of Flores, 113 M.
Type. 242. A. Stat. 310. Sumbawa, E., 73 M.
415. E. Stat. 318. Off Kangeang Id, N. E. of E. end of Java, 88 M.

Cambridge, Mus. Zool.: —

Singapore, 5—10 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.

Zoarium robust, young colonies delicate; the branches biserial, convex on the frontal side, strongly carinate basally. Cryptocyst broad, sloping down to the body-cavity, without a distinct oral shelf. Spines usually 1—2 on each side; sometimes wanting and often seen with difficulty in the fully developed state. Scutum originating near the middle of the opesia, its stalk broad and strong, its lamina variable, either with distinct proximal and distal lobes or only slightly enlarged, not filling the opesia, its direction transverse, its cavity narrow. Frontal avicularia inconspicuous, only the inner one developed. Marginal avicularia minute, situated on the vibracula, opposite the distal end of the orifice. Vibracula large, covering the basal surface, and forming a strong median keel, their long setal groove crossed by a calcareous bridge, at a lower level than the edges of the rostrum, close to the articulation, on the outer side of which is a very conspicuous, broad tooth. Seta (fig. 10) long and strong, markedly serrated on one side distally, a delicate longitudinal flange in the serrated part, opposite the teeth. Ovicells short, broader than long, the ectooecium extending only to the distal and lateral margins of the frontal surface.

As in other species, young colonies are so much more delicate than old ones that they might be mistaken for a distinct species. They agree with old colonies in their scuta and ovicells, but the vibracular seta is much more slender and is either not serrated or has mere vestiges of branches. In the old state the frontal surface has a regular cylindroidal shape, the scuta and other parts being in the same curved surface. The basal surface is strongly carinate, so that a transverse section would be a triangle with the frontal side convex. The strong transverse scuta, more or less expanded at the ends, the large projecting vibracula, forming lateral serrations of the branches, the short ovicells with a large frontal fenestra, and the small, single, frontal avicularia are characteristic features.

In zooecial characters *C. transversa* resembles *C. grandis* Hincks (1881, AMNH, 5, VIII, p. 2), which differs from it in being pluriserial and in having occasional gigantic frontal avicularia. It appears to be also related to *C. glabra* MacGillivray, 1886 (see 1887, PZV, XIV, p. 142, Pl. 137, figs 2—4), which differs from it in its larger spines and in the large size of the frontal avicularia.

5. **Scrupocellaria** Van Ben.

Scrupocellaria Van Beneden, 1845, NAMHN, XVIII, p. 26.
Scrupocellaria Harmer 1923, JLS, XXXV, pp. 316, 357.
Scupocellaria (*errorim*) Gray, 1848, BMRA, p. 111.
Cellarina (pars) Van Beneden, 1848, BARB, XV, 1, p. 70 (nec *Cellarina* D'Orbigny, 1851, PFTC, p. 181).

Licornia Van Beneden, 1850, BARB, XVI, p. 656.
Crisina Van Beneden, 1850, l. c. (nec *Crisina* D'Orbigny 1853: see HARMER, 1915, Siboga Report, XXVIII*a*, p. 137).
Savignella Van Beneden, 1850, l. c. (nec *Savignyella* Levinsen, 1909, MSSB, p. 274).
Monotypical. Genotype, *Sertularia scruposa* Linn., 1758, SN, p. 815.

Zoarium biserial. Opesia more or less oval, sometimes reduced by a cryptocyst of slight extent, usually with spines at the distal end; a gymnocyst of varying extent on its proximal side. Operculum seldom distinct, scutum present or wanting. Each zooecium typically provided with a single frontal avicularium, on the proximal or inner side of the opesia, a marginal avicularium at its distal end, and a basal vibraculum at its proximal end. Avicularia of the pointed type, the rostrum usually simple and aquiline, or occasionally trifoliate. Vibraculum on the outer side of the basal surface, usually projecting beyond the edge of the branch, its rostrum with a shallow groove and its body-cavity divided by a septum into two chambers. The larger, distally placed chamber contains the muscles, and the smaller proximal chamber has a fenestra which gives rise to a rootlet, in some of the proximal members of the colony at least. Seta without lateral branches. Rootlets commonly with barbing spines and not forming marginal bundles. Ovicells hyperstomial, porous or imperforate. At a bifurcation the proximal ends of the zooecia F and G are in contact on the basal side of the axillary zooecium (E), the joint passing through the participating zooecia in such a way that the proximal ends of F and G are shorter than those of C and D, the opesiae of which may be traversed by the joint.

In a certain number of species of *Scrupocellaria*, the scutum is absent, while in others, as in *S. diadema* and *S. cyclostoma* (both figured by BUSK, 1852, BMC, Pl. XXVIII) it is commonly wanting in the more proximal members of the colony. The frontal avicularia may be greatly reduced in number or even completely wanting; and the vibracula are apparently absent in *S. serrata*. The marginal avicularia seem to be always present, though sometimes reduced in number. All these heterozooecia, in the positions described, seem to have formed part of the original inheritance of the genus; and, if any of them are absent, this must be regarded as due to reduction. The apex of the pointed mandible has a spike set more or less at right angles to its blade. In many species, certain avicularia are enlarged or gigantic; most commonly the frontal avicularia of the axillary zooecia, or some of the marginal avicularia. A type with trifoliate rostrum and mandible bearing additional teeth (usually two) occurs in so many species not closely related, in either the marginal or frontal series, that it may be supposed to have been present at an early stage in the evolution of the genus. The mode of bifurcation is remarkably constant. As shown in Pl. XXVI, fig. 6, the inner zooecia of both branches are derived from the axillary zooecium E, and to this rule I have found no exception. In *S. delilii* and *S. maderensis*, in which the marginal avicularia are large and obviously aquiline, each of the zooecia F and G is provided with a vibraculum, and two of these structures accordingly appear in the axil. The ovicells in this group are generally imperforate, or at most provided with a single frontal fenestra. In the other species (except *S. serrata*) only one vibraculum appears in the axil (fig. 6, *ax. v.*). The base of each branch, at a bifurcation, is traversed by a joint, developed, as usual in jointed Polyzoa, by the absorption of an annulus of the originally continuous calcareous wall. Before this absorption takes place, a strong tube of chitin is formed as a lining of the outer wall of the zooecium, and the polypide passes through this tube. In the more robust species at least

(Pl. XXVI, figs 14, 15) the joint becomes strengthened, in the older zooecia, by the formation of a number of other tubes, each developed on the inner side of its predecessor and projecting beyond it at both ends. The result is a highly characteristic system of chitinous tubes arranged en échelon; this formation necessitating a corresponding arrangement in the thickened calcareous wall at each end of the joint, as figured by CLAPARÈDE (1870, ZFWZ, XXI, Pl. IX, fig. 1 C)[1]). This is a mechanical device which appears to be admirably adapted to give strength combined with flexibility.

WATERS (1913, BEA, p. 472) has called attention to differences in the position of the joint; and I have found (1923, p. 321), in agreement with his statements, that this character is useful in distinguishing genera and species. In most species of *Scrupocellaria* the opesia of the outer zooecium at the base of the internode lies in such a position that the joint passes across it, sometimes at its middle (*S. diadema*, Pl. XXV, fig. 23, and *S. ferox*), sometimes (in the other Siboga species not here mentioned) merely involving its proximal end (fig. 26). In *S. spatulata* (Pl. XXVI, fig. 4), *S. delilii* and *S. maderensis*, the joint traverses the outer zooecium on the proximal side of the opesia. The activities of the zooecium are not impaired when this happens, since the polypide remains functional.

The ovary of *Scrupocellaria* is on the basal wall, near its distal end (CLAPARÈDE, op. cit., p. 165; — WATERS, 1913, BEA, p. 476). According to WATERS (1909, JLS, XXXI, p. 132; — 1913, p. 476) the testis is in the form of a curved cylindrical cord. I have found this structure in certain species, but I have no proof that it is really a testis, though this view may be correct.

The rootlets have often been described as possessing recurved barbs, resembling the thorns of a bramble; though these have not been found in all species. I doubt whether this character is of specific value; and I have evidence confirming a suggestion made by PEACH (1877, JLS, XIII, p. 479) that the thorns are developed in response to the stimulus of a particular substratum, and specially when the rootlets are embedded in a Sponge. HINCKS (1877, AMNH, 4, XX, p. 218) came to a similar conclusion.

Key to the Siboga species of *Scrupocellaria*.

1	Scutum wanting		2.
	Scutum present		3.
2	Ovicells elongate, the pores not tubular. Frontal avicularia raised, with the rostrum curved round the proximal margin of the opesia	1.	*S. ferox.*
	Ovicells short, the pores on tubular projections. Frontal avicularia with straight rostrum	6.	*S. diadema.*
3	Marginal avicularia large, simple, giving the branch a serrate appearance. Two vibracula in each axil.		4.
	Marginal avicularia trifoliate, all large. Vibracula wanting. Scutum much branched.	2.	*S. serrata.*
	Marginal avicularia mostly small. One vibraculum in each axil.		5.

1) See also my earlier paper (1923, JLS, XXXV, pp. 322, 325, 326 and 357), for this and other characters.

4	Scutum filling the opesia, its distal border truncate	4. *S. maderensis.*
	Scutum not filling the opesia, its distal border usually pointed. . .	3. *S. delilii.*
5	Scutum strong, comparatively narrow at the middle of the opesia, its most expanded portion axe-shaped and on the outer side . . .	5. *S. securifera.*
	Scutum various, its expanded portion, if present, lying mainly over the middle of the opesia	6.
6	Frontal avicularia produced externally into a crescentic lobe forming a raised border to the proximal margin of the opesia. Scutum very large	8. *S. curvata.*
	Frontal avicularia not forming a raised border to the opesia	7.
7	Joints on the proximal side of the opesia of the outer zooecium at a bifurcation	10. *S. spatulata.*
	Joints traversing the opesia of the outer zooecium	8.
8	Scutum very variable, linear, oval or variously branched. Ovicells short, with tubular pores.	6. *S. diadema.*
	Scutum expanded, more or less oval, usually with recurrent caecal canals	9.
9	Scutum large, covering most of the opesia. Spines 5 (2 external), mostly short, the proximal pair stout and bifurcate. Frontal avicularia not much raised, with compressed rostrum	7. *S. obtecta.*
	Scutum smaller. Spines 6 (3 external), one or one pair very long and sometimes bifurcate, the proximal outer spine small and branched. Frontal avicularia (often absent) subcylindrical, more or less erect.	9. *S. longispinosa.*

1. *Scrupocellaria ferox* Busk (Pl. XXV, figs 1—6).

Scrupocellaria ferox Busk, 1852, VR, p. 370. Louisiade Archipelago; — 1852, BMC, p. 25, Pl. XXII, figs 1, 2, 5.

Scrupocellaria ferox Waters, 1913, BEA, p. 476, Pl. LXVIII, figs 11—15; Pl. LXIX, figs 7, 20. Zanzibar, British E. Africa.

Scrupocellaria cyclostoma Kirkpatrick, 1890, AMNH, 6, V, p. 16 (no description). Tizard Bank, 27 fath., China Sea (nec *S. cyclostoma* Busk, 1852).

2.A. / 433.A.	Stat.	7.	Batjulmati, Java, coral-reef.
335.A.	Stat.	37.	Sailus Ketjil, Paternoster Is, 0—27 M.
281.B. / 442.A.	Stat.	43.	Pulu Sarassa, Postillon Is, 0—36 M.
319.A.	Stat.	50.	Badjo Bay, W. Flores, 0—40 M.
31.A.	Stat.	53.	Nangamessi Bay, N. Sumba, 0—36 M.
365.A.	Stat.	93.	Tawi-Tawi Is, Sulu Archipelago, 12 M.
473.A.	Stat.	99.	North Ubian, Sulu Archipelago, 16—23 M.
78.A.	Stat.	105.	Sulu Archipelago, 275 M.
97.B.	Stat.	123.	Biaru Id, N. E. of Celebes, 27—36 M.
107.D.	Stat.	144.	S. of Halmaheira (Djilolo), 45 M.
520.A.	Stat.	209.	Kabaëna Id, S. of S. E. Celebes, 22 M.
375.A.	Stat.	213.	Saleyer, S. of Celebes, 0—36 M.
360.F.	Stat.	240.	Banda, Banda Sea, 0—45 M.
299.H.	Stat.	273.	Jedan, Aru Is, 13 M.
251.A.	Stat.	315.	Paternoster Is, N. of Sumbawa, 0—36 M.

Cambridge, Mus. Zool.: —

Singapore, 7 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.

British Museum: —

54. 11. 15. 76 (type), 99. 7. 1. 779, 6540, 6543, Louisiade Archipelago ('Rattlesnake'); 99. 7. 1. 778, Australia ('Rattlesnake').

89. 8. 21. 13, Tizard Bank, China Sea (recorded by KIRKPATRICK as *S. cyclostoma*).

Zoarium coarse; zooecia large, the opesia occupying most of the frontal surface, wider distally, with a slight cryptocyst proximally. Scutum wanting. Oral spines vestigial, 4 sometimes indicated, distally and at the sides of the orifice. Frontal avicularia varying greatly in size, the largest immediately on the proximal side of a bifurcation and belonging to the outer side of the branch, this series generally diminishing regularly towards the proximal end; some very small. These avicularia (fig. 2) consist of a broad base, rising obliquely so as to overlap the proximal end of the opesia, the rostrum directed outwards, very aquiline, curved, compressed and asymmetrical: the mandibles acute, their distal half linear in the larger avicularia (figs 5, 6). Marginal avicularia extremely small, situated over the base of the vibraculum. Vibracula large, visible from the frontal surface, the seta greatly exceeding a zooecium in length, its tip incurved. A single vibraculum in the axil. Ovicells large, with large, not tubular pores. Joint traversing the outer zooecium through the middle of its opesia, the inner half formed of a complete chitinous tube, the outer half of a broad chitinous band on the basal side only. Rootlets with barb-like thorns.

This handsome species resembles *S. securifera* in the large size of its zooecia, but it differs from this and all the other species found in having no scutum. The frontal avicularia are distinctive, from their shape (fig. 2) and from the large size of those preceding a bifurcation. The proximal margin of the rostrum is convex, and overlies the concave distal margin, owing to the oblique angle made with the frontal surface of the branch. Many of the frontal avicularia are very small, and this is constantly the case on the distal side of an ovicell. Oral spines are represented by minute points on some of the zooecia, but a rather larger one occurs on the inner distal margin of a fertile zooecium; or two, perhaps representing a forked spine. The ends of the vibracula are conspicuous in frontal view. Their proximal opesia is on this surface, bending round the distally placed end of the vibraculum to its basal surface, where it is separated from the rest of the opesia by a broad calcareous bar (fig. 3). Two pairs of strong muscles occupy the vibraculum, one near each surface. These obviously move the seta in opposite directions, and I think that the extensors and flexors are separated by the calcareous bar. The great length and the stout character of the seta (fig. 1) are characteristic of the species. The single axillary vibraculum belongs to the zooecium F or G.

The peculiar joint, which is similarly developed in certain other species, traverses the middle of the opesia of the outer zooecium, and its chitinous part, in this zooecium, is developed on the basal side only. The inner half of the joint is a complete chitinous tube. WATERS (1913, Pl. LXIX, fig. 7) seems to have supposed that the joint does not traverse the outer zooecium. In both halves the joint is formed of several chitinous layers, as many as four in the older zooecia. Fig. 4 shows young joints, with only two layers.

The vibraculum shows the usual fenestra (fig. 3) in the part situated proximally, for the origin of a rootlet, which is not always developed. The rounded elevation which carries this

fenestra is separated by a calcareous wall from the larger distal portion, which contains the strong muscles. The rootlets have a certain number of very acute, thorn-like barbs, directed towards their origin. The terminal rosette-plates are multiporous. Some of the zooecia contain a worm-like body (fig. 4, left zooecium), regarded by Waters (1913, p. 476) as a testis, but it may be merely a special development of the funicular tissue.

The specimen from Singapore is overgrown by *Crepis longipes* (p. 318), the zooecia of which have grown, in two instances, over the palatal surface of a large frontal avicularium. In one of these the mandible is closed over the narrow proximal end of a *Crepis* zooecium. It is difficult to understand how the *Crepis* succeeded in assuming this position, since its walls must have been soft before calcification occurred.

The Busk Collection (Brit. Mus.) includes four specimens from the original 'Rattlesnake' material; and it seems clear that 54. 11. 15. 76, from the Louisiade Archipelago, should be regarded as the type. MacGillivray does not include this species in his Victorian Catalogue (1887, PRSV, XXIII, p. 200); and, although Busk gave Bass Straits as a locality, his corresponding 'Rattlesnake' slide is merely labelled "Australia". I have no satisfactory evidence that *S. ferox* occurs in S. Australia, where it seems to be replaced by *S. cyclostoma* Busk (see 1852, BMC, p. 24), an allied species differing from it in the following respects. The branches of *S. cyclostoma* are flat, the zooecia lying in the same plane, while in *S. ferox* they have a median keel, from which the zooecia slope basally. In *S. cyclostoma* small spines are present, the marginal avicularia are larger than in *S. ferox*, and the frontal avicularia are free distally, instead of being adnate to the edge of the opposite opesia along their median border. The zooecia in the fertile branches of *S. cyclostoma* have well developed scuta, the cavities of which are "cervicorn" (see p. 377, under *S. diadema*).

2. *Scrupocellaria serrata* Waters (Pl. XXV, figs 7, 8).

Scrupocellaria serrata Waters, 1909, SRS, p. 133, Pl. X, figs 11—14. Suez, about 5 fath.

507. A. Stat. 164. W. of N. end of New Guinea, 32 M.

Zoarium delicate, the opesia short, its edge thin and much raised, so that the frontal membrane may be deeply depressed. Spines 6; — 3 external, 1 distal, 2 internal, not bifurcate, jointed at the base. Scutum much raised, variably branched, the branches narrow and usually acute. Frontal avicularia and vibracula not found. Marginal avicularia present on many of the zooecia, all gigantic, much raised and projecting outwards and distally; the rostrum expanding distally, where it is strongly trifoliate; the mandible of similar form, with 3 terminal, long and linear spikes, at right angles to its principal surface, the outer border with a similar spike more proximally. Ovicells with numerous pores.

S. serrata is represented only by a single dry preparation, in which some decalcification has occurred. The internodes may be very short, consisting of only 5 zooecia. The much branched scutum and the enormous marginal avicularia, all of one kind, distinguish it from other species. Although I have found neither frontal avicularia nor vibracula, in agreement with Waters, I think it must be referred to *Scrupocellaria*, and that the excessive development of one kind of avicularium may be correlated with the suppression of the other kinds, and even of the vibracula,

which are sometimes absent in *S. scabra*. The bifurcation is of the usual type, and the joint appears to traverse the proximal end of the opesia of the outer zooecium.

According to WATERS the spines are 2 outer and 1 inner; and some of them appear, from his fig. 12, to be repeatedly jointed. In other respects the Siboga specimen agrees well with his description, as in the absence of frontal avicularia and of vibracula, in the size of the marginal avicularia and particularly in the form of their mandibles, which possess 3 distal spikes and 1 more proximally placed, as shown by him in fig. 14.

3. *Scrupocellaria delilii* (Aud.). (Pl. XXV, figs 12—15).

Crisia delilii Audouin, 1826, EPS, p. 242; 1828, p. 72, Red Sea; SAVIGNY, DE, Pl. XII, figs 3^1—3^5.
Cellularia savignyi D'Orbigny, 1851, PFTC, p. 50.
Scrupocellaria delilii Busk, 1859, QJMS, VII, p. 65, Pl. XXII, figs 1—3. Madeira.
Scrupocellaria delilii Waters, 1897, JLS, XXVI, p. 7, Pl. I, figs 14, 15. Mediterranean; — 1899, JRMS, p. 15. Madeira.
Scrupocellaria delilii Norman, 1909, JLS, XXX, p. 284. Madeira.
Scrupocellaria delilii Barroso, 1923, BSEHN, XXIII, p. 189. Valencia, Spain.
Scrupocellaria macandrei Busk, 1852, BMC, p. 24, Pl. XXIV, figs 1—3. Spain.
Scrupocellaria macandrei Heller, 1867, VZBGW, XVII, p. 87. Adriatic.
Scrupocellaria macandrei Haswell, 1880, PQC, p. 37. Queensland.
(?) *Scrupocellaria macandrei* Yanagi and Okada, 1918, AZJ, IX, p. 415. Japan.
(?) *Scrupocellaria macandrei* Robertson, 1921, BBB, p. 36. India, W. coast.

37. M. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
501. J. Stat. 163. Seget, N. end of New Guinea, 0—29 M.
344. B. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
299. F. Stat. 273. Jedan, Aru Is, 13 M.

Cambridge, Mus. Zool.: —

BM Torres Straits, 120, A. C. HADDON, Reg. Feb. 24, 1898.
BM Japan, 18. D, off Tokyo, 25 fath., A. OWSTON, Reg. June 23, 1902.
Port Denison, Queensland, W. A. HASWELL Coll. (undetermined), Australian Museum, Reg. Oct. 23, 1899.

British Museum: —

Spain, BUSK Coll., 54. 11. 15. 78 (type of *S. macandrei*).
Sandwich Is, Challenger Coll., 99. 7. 1. 784 (as *S. ornithorhynchus*).

Zoarium moderately coarse, the branches serrated by the projection of the marginal avicularia. Spines 2 external, 1 internal. Opesia occupying about half the front, cryptocyst slight. Scutum not completely filling the opesia, its stalk originating on the distal side of the middle, produced into two lobes, the distal one sometimes narrow and pointed, the proximal lobe rounded; not articulated with the edge of the opesia; its cavity produced into both lobes, with a median, external portion sometimes distinguishable (fig. 12). Frontal avicularia frequently absent. Marginal avicularia large and aquiline, strongly projecting; occasionally replaced by a large avicularium with trilobed rostrum and a mandible ending distally in three spikes. Vibracula small, hardly visible frontally, the seta short; two occurring in the axil. Ovicells rather large, imperforate except for a single frontal fenestra. Bifurcation normal, the joint traversing the outer zooecium on the proximal side of its opesia, which it just reaches. Rootlets occasionally with barbing thorns.

S. delilii is distinguished from *S. maderensis* by its scutum not filling the opesia and by

not having a truncate distal border; as well as by the smaller number of spines. In the occasional replacement of a normal marginal avicularium by one of the trifoliate type (fig. 14) it resembles certain other species of the genus. The rostrum of these avicularia is produced into three prominent cusps, and the mandible ends in three linear spikes corresponding with the cusps. The vibracula have a setal groove which is shorter than in *S. maderensis*, and is only slightly oblique. 299. F[1] shows an abnormality which is not common in the genus, an axillary zooecium having produced a scutum on each side. The internodes may reach a considerable length, with as many as 11 pairs of zooecia.

Attention has often been directed to the occurrence of two vibracula in the axil, and WATERS (1897, pp. 7—9) has remarked on this feature, mentioning *S. scruposa*, *S. delilii*, *S. scrupea*, *S. ornithorhynchus* and *S. incurvata* in this connexion. In his 1913 paper (BEA, p. 477) he adds *S. macandrei*[1]) to this list. It appears that two axillary vibracula typically occur in species in which the marginal avicularia are large. *S. scruposa* differs from the others mentioned in having no scutum.

The present species may be determined with some confidence as *S. delilii* (Aud.). It appears to differ from *S. scrupea* (S. W. coast of England, BUSK Coll., 54. 11. 15. 79) in the following respects; the characters of *S. scrupea* being placed in brackets. The spines are 1 or 2 external, 1 internal (3, 2); the cryptocyst is very slightly developed and is not wider proximally (more developed and wider proximally); the surface of the branch is hardly interrupted frontally by the outlines of the zooecia (margins of the zooecia slightly raised); the scutum commonly, though not always, originates at a short distance from the inner spine, and its distal lobe is well developed (scutum originates close to the inner spines, its blade mainly formed by the proximal lobe); the outer border of the marginal avicularia is not continued in a straight line to the proximal end of the zooecium, as seen in frontal view, the zooecium being subcylindrical at its proximal end (outer border of these avicularia passing in a straight line to the proximal end, which is much narrower than the distal end).

In the figured specimens (figs 12—14) the distal lobe of the scutum is pointed, resembling that of *S. ornithorhynchus* Wyv. Thoms. (see under *S. maderensis*). In others the distal lobe is broad and rounded, and completely agrees with SAVIGNY's fig. 3[4].

S. macandrei was described by BUSK (1852, p. 24) from the coast of Spain, and I have satisfied myself, from an examination of the type-slide (54. 11. 15. 78) that it belongs to the present species, with which it agrees in the long internodes, consisting in some cases of at least 19 zooecia, in the reduction of the number of spines (of which BUSK described only 1 vestigial outer spine), in the ovicells, which may have a small frontal fenestra, as in fig. 13, and in the shape of the vibracula. BARROSO (1923) has maintained, however, that *S. delilii* and *S. macandrei* are distinct, but from his reference to WATERS' fig. 5 (1913) and from his account of the vibracula, I think that the specimen placed by him in the latter species is really *S. maderensis* as described below. In the Challenger Report BUSK (1884, p. 23) referred to *S. macandrei* a specimen from the Cape Verde Is which I believe to belong to the following species; and a large amount of confusion has resulted from this action.

1) I give his reference to *S. macandrei* under the synonyms of the following species.

4. *Scrupocellaria maderensis* Busk. (Pl. XXV, figs 16—19).

Scrupocellaria maderensis Busk, 1860, QJMS, VIII, p. 280; — 1861, QJMS, N. S., I, p. 77, Pl. XXXII, fig. 1. Madeira.
Scrupocellaria macandrei Busk, 1884, Chall., p. 23, Pl. XI, figs 4—4*b*. Cape Verde Is (nec Busk, 1852).
(?) *Scrupocellaria macandrei* Philipps, 1899, WZR, pp. 439, 442. Lifu, Loyalty Is.
Scrupocellaria macandrei Thornely, 1912, PIOS, p. 140. Indian Ocean.
Scrupocellaria macandrei Waters, 1913, BEA, p. 477, Pl. LXVIII, figs 5, 6. Zanzibar.
Scrupocellaria macandrei and *S. maderensis* (pars) Norman, 1909, JLS, XXX, p. 284. Madeira.
Scrupocellaria scrupea Thornely, 1905, PGM, p. 109. Ceylon.
Scrupocellaria scrupea var. *dongolensis* Waters, 1909, SRS, p. 134.
(?) *Scrupocellaria gilbertensis* Maplestone, 1909, PRSV, XXI, p. 411, Pl. XXVI, fig. 2. Gilbert Is.

31. I. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M.
427. F. Stat. 60. Haingsisi, Samau Id, W. Timor, 0—36 M.
37. K. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
483. E. Stat. 117. Kwandang Bay, N. Celebes, 80 M.
98. A. Stat. 125. Siau Id, N. E. of Celebes, 27 M.
629. B. Stat. 164. W. of N. end of New Guinea, 32 M.
609. A. Stat. 225. Off S. Lucipara Id, Banda Sea, 894 M.
208. G. Stat. 282. Timor, E., 0—54 M.
218. C. Stat. 301. Rotti Id, E., S. W. of Timor, 0—45 M.
248. F. } Stat. 310. Sumbawa, E., 73 M.
249. K. }

Cambridge, Mus. Zool.: —

BM Japan, 7. W, 49. I, off Tokyo, 30 fath. A. Owston, Reg. June 23, 1902.
Japan, from rooting spicules of *Euplectella marshalli*, K. Mitsukuri, Reg. Sept. 23, 1896.
Madagascar, 5 miles S. of Mananyara, S. E. coast, A. Smith, Reg. Mar. 9, 1899.
BM Ceylon (as *S. scrupea*), Miss L. R. Thornely, Reg. Apr. 25, 1906, 5.
BM Lifu, Loyalty Is (as *S. macandrei*), A. Willey Coll. (Miss Philipps) Reg. Mar. 1, 1898.

British Museum: —

Madeira (type of *S. maderensis*), Busk Coll., 99. 7. 1. 780.
Cape Verde Is, 1070—1150 fath. (as *S. macandrei*), Busk Coll. (Challenger), 87. 12. 9. 103 and 104.
Amirante Is (as *S. macandrei*), H. M. S. Alert, 82. 10. 18. 141—142.
Tizard Bank, China Sea (not determined), 89. 8. 21. 30 and 108.

Zoarium moderately coarse, the branches serrated by the projection of the marginal avicularia. Spines 2—4 external, 1—2 internal. Opesia occupying half the front or less, a broad cryptocyst on its proximal side. Scutum normally filling the opesia, its stalk originating close to the distal end, its distal border straight and transverse, its proximal border rounded, its outer border sometimes articulating distally with a tooth on the wall of the zooecium, its cavity simple; occasionally reduced. Frontal avicularia usually absent, sometimes present as rather elongated structures directed towards the stalk of the opposite scutum. Marginal avicularia variable in size, typically large, strongly projecting outwards, the rostrum aquiline. Vibracula moderate, extending some distance distally, where their outer part may be visible at the edge of the branch in frontal view; the rostrum very oblique and the seta short, not extending much beyond the opposite edge of the branch when directed transversely. Two vibracula in the axil. Ovicells oblique, the frontal surface flattened, imperforate or with a single large fenestra. Bifurcation normal, the joint

traversing the outer zooecium on the proximal side of its opesia. Rootlets with very strong barbing thorns, ending in complicated, branching, attaching laminae.

S. maderensis is characterised by the broad, crescentic cryptocyst on the proximal side of the opesia, which is typically filled by the scutum (figs 16, 18); a narrow, crescentic slit occurring between its free margin and the edge of the opesia. The cryptocyst is often finely denticulate on the outer side of this slit. At its outer distal corner the scutum usually articulates with a strong tooth formed by the edge of the opesia. In correlation with this firm attachment, the operculum occupies a well defined space, and is more chitinised than in most species of the genus. In a few cases the scutum remains free externally, and then has its distal margin rounded. This is specially the case in the deep water specimen 609. A, in which the scutum is much reduced and does not nearly fill the opesia. In other respects it has the normal features of the species.

In most of the specimens the frontal avicularia are wanting, but the marginal avicularia are constantly present and usually large and prominent. The vibracula have a nearly straight outer edge (fig. 17), this part being often visible in frontal view. Their median border is oblique, owing to the median slope of the rostrum; and the seta, though short, is strong and compressed near its proximal end (fig. 19). The spines are short and none are definitely distal. The ovicells are flattened frontally, and generally imperforate, sometimes showing a large frontal fenestra.

Under the preceding species I have pointed out that *S. macandrei* Busk, 1884, is distinct from the species so named by the same author in 1852, but that the specimens here described agree with it in their spines, which are more numerous than in *S. delilii*, in the well marked, crescentic, proximal cryptocyst, (usually) in the sharply defined opercular region, limited proximally by the transverse distal border of the scutum, in the characteristic oblique vibracula (fig. 17), and in their short setae.

In 1909 (p. 284) Norman stated that *S. maderensis* can hardly be distinguished from *S. macandrei*. The type-slide (99. 7. 1. 780) of *S. maderensis* shows that the Siboga specimens agree with this species in all essential features, and particularly in their cryptocyst, spines, scutum and ovicells. The basal side of the type is not visible and the characters of its vibracula cannot be ascertained.

S. ornithorhynchus was described, from Bass Straits, by Wyville Thomson (1858, NHR, V, p. 144) as having 4—5 long spines, a well developed proximal cryptocyst, and a narrow, curved, distal lobe in its scutum. The lobe appears to be variable in Victorian specimens, and others, but this species appears not to be identical with *S. maderensis*. *S. minuta* Kirkpatrick (1888, AMNH, 6, I, p. 73), from Mauritius, seems to have two vibracula in the axil and to be allied to the present species.

5. *Scrupocellaria securifera* Busk. (Pl. XXV, figs 9—11).

Scrupocellaria securifera Busk, 1884, Chall., p. 24, Pl. XI, figs 2—2*b*. Admiralty Is, N. of New Guinea.
Scrupocellaria securifera Kirkpatrick, 1900, AMNH, 6, V, p. 16. Tizard Bank, China Sea, 27 fath.

37.N. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
53.A. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.

177. E. Stat. 257. Kei Is, 0—52 M.
543. A. Stat. 260. Kei Is, 90 M.
411. B. Stat. 310. Sumbawa, E., 73 M.
251. B. Stat. 315. Paternoster Is, N. of Sumbawa, 0—36 M.

British Museum: —

Admiralty Is, N. of New Guinea, 87. 12. 9 113 and 114 (type).
Tizard Bank, China Sea, 89. 8. 21. 48 (recorded by KIRKPATRICK).

Zoarium coarse, resembling that of *S. ferox*. Zooecia short and broad, the opesia short, occupying about two thirds of the frontal surface, the cryptocyst well developed in old zooecia. 3 distal oral spines, directed distally, and a larger lateral spine, on each side, slightly bifurcate at its end. Scutum strong, hatchet-shaped, its distal edge nearly straight and transverse, its proximal edge more or less straight or concave, directed obliquely proximally. The scutum expands at its outer end, where it forms an intimate union with the external lateral spine distally and with a hook, produced by an external lobe of the frontal avicularium, or with the ovicell in fertile zooecia, proximally; its cavity moderately broad, and giving off one or two fine tubes at the outer end. Frontal avicularia of moderate size, directed obliquely, at an angle of 45°, towards the proximal and outer sides; the calcareous bar wanting. Marginal avicularia very small, lying on the vibracula. Vibracula large, visible from the frontal surface, the seta very long, its tip almost straight. A single vibraculum in the axil. Ovicells large, their walls porous, their frontal surface flattened. Bifurcation and joints as in *S. ferox*, but the outer part of the joint traverses the proximal part of the opesia and the gymnocyst of the outer zooecium. Rootlets usually without barbs.

S. securifera resembles *S. ferox* in external appearance, but is distinguished from it by its characteristic scutum, the outer edge of which does not fuse with the edge of the opesia (as seems to have been supposed by BUSK), a slit occurring between the two structures. The vibracula project as elevated mounds, on the basal surface, which is not the case in *S. ferox*. The rootlet-foramen is not proximally situated, as in that species, but is lateral and external, and of smaller size. The rostrum of the vibraculum is narrow, and possesses a narrow distal opesia, near the end which lies towards the proximal end of the zooecium.

While the bifurcation is usually normal, I have found a single case (543. A^2) of trifurcation, produced by a doubling of the rows from each of the zooecia A and B. Two axillary zooecia (E) are thus produced, and each gives rise to two distal successors. The inner derivatives of the two axillary zooecia have united to form the middle branch, their outer derivatives constituting the commencements of the inner series of the two outer branches. A single vibraculum occurs in each of the two axils.

In correlation with its shorter opesia, the joint-formation differs slightly from that of *S. ferox*. While in that species (Pl. XXV, fig. 4) the chitinous part of the joint is restricted to the region of the opesia of the outer zooecium, both gymnocyst and opesia are involved in *S. securifera*. In the region of the gymnocyst the chitinous tube is complete, extending round the frontal as well as the basal surface. The proximal end of the opesia also becomes strongly chitinous, without altering its form. Both chitinous tubes are flask-shaped (like the inner tubes of *S. ferox*), but are rather larger than in that species. The échelon-formation is even more

distinct, owing to a greater projection of the successive laminae, at their free ends. The polypide at first traverses the cavity of the chitinous tube (as in *S. ferox*), and the younger zooecia show no trace of a joint, which is developed, as usual, by resorption of the calcareous wall, with the concurrent production of the chitin. The joints are inconspicuous in dried specimens, as the calcareous wall is absorbed for a very short distance, forming a mere transverse slit across the basal wall. Transparent preparations are required to show that that the chitinous tubes are both large and strong. The joint appears to be completed, in old zooecia, by the loss of the scutum.

6. *Scrupocellaria diadema* Busk. (Pl. XXV, figs 20—25).

Crisia ciliata Audouin 1826, EPS, p. 241; 1828, p. 71; — Savigny, DE, Pl. XII, figs 2^1—2^5.
Scrupocellaria diadema Busk, 1852, VR, p. 370. Moreton Bay (Queensland); — 1852, BMC, p. 24, Pl. XXVIII, figs 1—3.
Scrupocellaria diadema Haswell, 1880, PQC, p. 37 (o). Queensland.
Scrupocellaria diadema Hincks, 1884, AMNH, 5, XIII, p. 357 (o); — 1887, JLS, XXI, p. 129, Pl. XII, fig. 6. Mergui Archipelago, Burma.
Scrupocellaria diadema Ortmann, 1889, ANG, LVI, 1, p. 22, Pl. I, figs 4*a*—*c*. Japan.
Scrupocellaria diadema Kirkpatrick, 1890, TS, p. 611 (o). Torres Straits.
Scrupocellaria diadema Thornely, 1905, PGM, p. 109 (o). Ceylon; — 1907, MPIM, p. 181 (o). Burma, India.
Scrupocellaria diadema Yanagi and Okada, 1918, AZJ, IX, p. 414. Japan.
Scrupocellaria diadema Marcus, 1921, KVAH, LXI, 5, p. 6, Pl. I, fig. 1. N. W. Australia; — 1921, IPBS, p. 4. Amboina, Singapore, Society Is; — 1922, AI, p. 425, Pl. XXIV, fig. 2 (joint). Aru Is, Amboina, S. of Java.
Scrupocellaria cervicornis Busk, 1852, VR, p. 370. Queensland; — 1852, BMC, p. 24. Pl. LXII, figs 1—4.
Scrupocellaria ciliata Busk, 1884, Chall., p. 23, Pl. XI, figs 5, 5*a*. S. of New Guinea.
Scrupocellaria annectens MacGillivray, 1887, PRSV, XXIII, p. 184, Pl. II, figs 1, 1*a*. E. of Sumatra.
Scrupocellaria gaspari Thornely, 1907, MPIM, p. 181, text-fig. Malay Archipelago, Andamans, Indian Seas.
Scrupocellaria jolloisii Robertson, 1921, BBB, p. 36. India, Burma, Malay Archipelago.

(o) signifies no description.

432. B. Stat. 2. Madura Strait, 56 M.
439. B. Stat. 37. Sailus Ketjil, Paternoster Is, 0—27 M.
380. A. Stat. 47. Bima, Sumbawa, N., 55 M.
16. F. Stat. 49a. Sumbawa, E., 69 M.
20. I. / 322. B. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
31. B. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M.
427. A. / 549. A. Stat. 60. Haingsisi, Samau Id, W. Timor, 0—36 M.
337. A. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
37. P. / 600. B. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
68. B. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.
92. B. Stat. 117. Kwandang Bay, N. Celebes, 80 M.
620. A. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M.
108. JA. Stat. 144. S. of Halmaheira (Djilolo), 45 M.
396. G. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
501. G. Stat. 163. Seget, N. end of New Guinea, 29 M.
139. A. Stat. 164. W. of. N. end of New Guinea, 32 M.
143. A. Stat. 166. W. of N. end of New Guinea, 118 M.

422.A. Stat. 181. Ambon, reef.
344.A. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
357.A. Stat. 240. Banda, Banda Sea, 0—45 M.
305.D. Stat. 273. Jedan, Aru Is, 13 M.
253.B. } Stat. 315. Paternoster Is, N. of Sumbawa, 0—36 M.
414.A. }
415.F. Stat. 318. Off Kangeang Id, N.E. of E. end of Java, 88 M.
555.A. Stat. 320. Java Sea, 82 M.
416.E. Stat. 321. Java Sea, 82 M.

Cambridge, Mus. Zool: —

Torres Straits, 27, 107, 166. A. C. HADDON, Reg. Feb. 24, 1898.
BM Singapore, 0—10 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.
Singapore, from a submarine cable, C. STEWART, Reg. Apr. 26, 1899.
Malay Peninsula, W. W. SKEAT, Reg. Nov. 30, 1899.
BM Ceylon, Miss L. R. THORNELY, Reg. Apr. 25, 1906.
Port Denison, Queensland (undetermined material), W. A. HASWELL Coll., Australian Museum, Reg. Oct. 23, 1899.
BM Japan, 10. B., 20—30 fath. A. OWSTON, Reg. June 23, 1902.

British Museum: —

Moreton Bay (Queensland), 54. 11. 15. 80 (type of *S. diadema* Busk).
Torres Straits, Challenger, 87. 12. 9. 107 (as *S. ciliata*), BUSK Coll.
Torres Straits, 83. 11. 29. 8 and 90. 3. 24. 43 (recorded by R. KIRKPATRICK as *S. diadema*).
Cumberland Is (Queensland), 54. 11. 15. 81 (type of *S. cervicornis* Busk).
Queensland (Port Molle), 82. 2. 23. 448—457 and (Port Curtis) 83. 11. 29. 7 (as *S. cervicornis*).
Madras, 91. 4. 30. 9 (undetermined).
Arafura Sea, 82. 2. 23. 370 and 497—506 (as *S. ciliata* and undetermined).

Zoarium coarse. Opesia often occupying about two thirds of the front, but varying in length. Scutum typically present, extremely variable, rarely completely absent, sometimes wanting in many of the zooecia, not filling the opesia; linear, oval with a cavity produced into recurrent caecal canals, or variably branched. Spines typically 5; — 2 external, 1 distal, 2 internal, the proximal spine on either side sometimes bifurcate. Frontal avicularia rarely wanting, typically present, at least in the fertile branches, compressed and raised, the mandible triangular. Axillary zooecium commonly bearing a gigantic frontal avicularium (fig. 20), the rostrum of which may be finely denticulate on each side, the mandible elongate, triangular. Marginal avicularia small, their palatal surface oblique. Vibracula moderate, the setal groove oblique, the rootlet-foramen lateral (fig. 25), the seta long. A single vibraculum in the axil (fig. 23). Ovicells very short, with large pores, each carried on a short tubular projection. Bifurcation normal, the joint traversing the middle of the opesia of the outer zooecium (fig. 23), the chitinous tubes en échelon. Rootlets sometimes with barbing thorns.

S. diadema, far the commonest of the genus among the Siboga dredgings, may be distinguished by its robust habit, by its short ovicells with large tubular pores, by its very variable scutum (sometimes wanting) and by the tendency to produce gigantic frontal avicularia on the axillary zooecia. The scutum may be comparatively large and oval (fig. 20), and such specimens have a considerable resemblance to *S. obtecta*, in which, however, the scutum is larger and the ovicells are longer, with smaller and more numerous, non-tubular pores. In 555. A

(fig. 23) I have found no scutum, and the spines are reduced, while in others the scutum is linear or variously branched (figs 21, 22). In spite of these variations the presence of ovicells or of gigantic, axillary, frontal avicularia generally enables the species to be recognised. The spines are fairly constant in number, and the ovicells (figs 20—23) are characteristic and usually present.

There can be no question that the present species is *S. diadema* Busk, which Busk considered later (1884) as a synonym of *Crisia ciliata* Audouin (nec Linn.). In this conclusion I think he was right, Savigny's figure (Pl. XII, fig. 2^4) showing the characteristic ovicells and a bifurcate proximal outer spine. Audouin stated that his specimens were determined as *C. ciliata* by Lamouroux, but *C. ciliata* Lamx. (see 1816, PCF, p. 139) is *Bicellariella ciliata* (L.), and the trivial name accepted by Audouin may thus be disregarded. *Acamarchis jolloisii* Aud. (Savigny, DE, Pl. XI, figs 2^1—2^5) appears to be nearly related to *S. diadema*, as I conclude from the examination of specimens from the Suez Canal, kindly lent to me by Miss A. B. Hastings. The species is characterised by the presence of connecting tubes between the branches, as in *Canda*, by the absence of the scutum in the proximal parts of the colony and by the appearance of this structure as a linear, overarching spine in the fertile zooecia; — the first and third characters being well represented in Savigny's figures. *S. mansueta* Waters (1909, JLS, XXXI, p. 134) seems to be a synonym of *S. jolloisii*, which is described separately by Waters on p. 132 of the same paper, with a note in a later paper (1910, t. cit., p. 254) of the occurrence of a gigantic marginal avicularium with a deeply furcate mandible on a single specimen from the Red Sea. I have found no trace of avicularia of this description in the large series of *S. diadema* examined by me. From what Miss Robertson (1921, p. 36) says of the common occurrence of the species in the Malay Archipelago, I think her *S. jolloisii* is probably *S. diadema*.

S. annectens MacGillivray seems to be clearly a synonym of *S. diadema*, this author referring both to the serrated rostrum of the frontal avicularia and to the occurrence of enlarged avicularia of this series on the axillary zooecia. *S. gaspari* Thornely, from the same locality as *S. annectens*, is probably a form of *S. diadema* in which no scuta were visible. Marcus (1921) regards *S. diegensis* Robertson as a further synonym, but I do not accept this, in view of the longer ovicells of Miss Robertson's species, in which, moreover, the joint does not traverse the opesia of the outer zooecium at a bifurcation.

The references in literature to *S. cervicornis* are probably not all based on the same species. Busk's type-material, in the British Museum, consists of a single slide, originally a fluid mount, which had dried up in such a way that the characters of the fragments it contained were quite indistinguishable. I have re-mounted these fragments in Canada balsam, but they had unfortunately undergone some decalcification, so that the scutum, whose "cervicorn" markings are referred to in the trivial name, has lost its blade, and can only be recognised by the base of its stalk. Ovicells are absent, but the branched internal spine, figured by Busk on the distal side of the scutum, is just discernible. The most significant feature visible in its present condition is a gigantic axillary frontal avicularium, not mentioned by Busk, but of precisely the same form as those so frequently found in *S. diadema*. 501. G, from the Siboga Collection (fig. 20) resembles the type-specimen of *S. cervicornis* in the large size of the scutum and in its "cervicorn" cavity, in the presence of an inner bifurcate spine just distally to it (the outer proximal spine also

bifurcate), in the identity of the total number (5) of spines, and in the presence of gigantic axillary avicularia. I believe this to be Busk's *S. cervicornis*, though I cannot attempt to decide how many of the numerous other citations of this name are correct. It agrees with typical *S. diadema* in most of its characters, notably in the ovicells, the position of the joints, the gigantic axillary avicularia, and the form, position and size of the other frontal avicularia, the marginal avicularia and the vibracula. The scuta are larger than in any other specimen found, but Busk figured (1852, Pl. LXII, fig 1) one minute, trifurcate scutum; and a few of the scuta in 501. G are smaller than those shown in fig. 20. One of the Singapore specimens (F. P. Bedford) helps to bridge the interval; some of its scuta being enlarged and cervicorn, though not so large as in 501. G, while other zooecia have scuta like those of typical *S. diadema* or are devoid of these structures.

Examination of the specimens which I have referred to *S. diadema* has convinced me that caution must be used in distinguishing species of this genus by even striking differences in the scuta, especially if the material consists solely of small mounted fragments. While a few specimens of *S. diadema* seem to be entirely devoid of scuta, this may be merely a growth-phase. Many colonies show no scuta on the proximal branches, these structures only commencing to appear near the distal ends of the branches, particularly in those which are provided with ovicells. In their younger condition these specimens would have shown no scuta. In many of these colonies the more proximal scuta are linear, and hardly distinguishable from simple incurved spines. In approaching the ends of the branches the scuta may become more complex, either more expanded and becoming cervicorn, or more branched, in which case they resemble those of *S. bertholletii* or of *S. reptans*. I have found a striking confirmation of these conclusions in specimens (Brit. Mus.) of *S. cyclostoma*, a species which, according to Busk (1852, BMC, p. 24), possesses no scuta [1]). In a specimen from Victoria, in the Hincks Collection (99. 5. 1. 340, determined as *S. annectens*) the proximal parts agree with MacGillivray's description in having no scuta, while the fertile branches have large scuta, with cervicorn cavities, the ovicells resembling those of *S. diadema* in their pores, but being somewhat longer than in that species.

Marcus (1922, AI, p. 425, Pl. XXIV, fig. 2) has described and figured chitinous joints en échelon in *S. diadema*.

7. *Scrupocellaria obtecta* Haswell (Pl. XXVI, figs 16—18).

Scrupocellaria obtecta Haswell, 1880, PQC, p. 37. Queensland.
Scrupocellaria obtecta Thornely, 1912, PIOS, p. 139. Indian Ocean.
Scrupocellaria obtecta Marcus, 1921, IPBS, p. 5, Pl. I, fig. 3. Tahiti.
Scrupocellaria cervicornis Thornely, 1905, PGM, p. 109 (no description). Ceylon.
Scrupocellaria cervicornis Waters, 1909, SRS, p. 166. Red Sea, Queensland.
Scrupocellaria cervicornis Waters, 1913, BEA, p. 477, Pl. LXIX, figs 3, 4. British E. Africa.
(nec *S. cervicornis* Busk).

37. ZC. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
459. L. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
108. Q. Stat. 144. S. of Halmaheira (Djilolo), 45 M.
501. Q. Stat. 163. Seget, N. end of New Guinea, 29 M.
242. C. Stat. 310. Sumbawa, E., 73 M.

1) See also p. 369, under *S. ferox*.

Cambridge, Mus. Zool.: —

BM Port Denison, Queensland, W. A. HASWELL Coll. (not determined), Australian Museum, Reg. Oct. 23, 1899.

BM Ceylon, Miss L. R. THORNELY, Reg. Apr. 25, 1906, 3 (as *S. cervicornis*).

Zoarium rather coarse; zooecia of moderate width, the opesia usually occupying about two thirds of the opesia, with hardly any cryptocyst. Oral spines typically 2 distal, 2 external and 1 internal, the second external and the internal spines stout and bifurcate or even trifurcate, their inner branches often meeting over the orifice. Scutum large, its distal edge raised, usually rounded and not truncate, the proximal end narrower and rounded; its cavity branched as in *S. curvata*. Frontal avicularium not forming a raised edge on the proximal side of the opesia; with an elongate, narrow rostrum and a linear or triangular mandible, bearing a strong terminal spike (fig. 18). Marginal avicularium usually minute, situated just externally to the opesia and overlying the vibraculum. Vibraculum large, visible in frontal view, the seta much exceeding the zooecia in length; close to the outer margin on the basal side, the rostrum elongate and narrow, with a small opesia in the morphologically distal half and a rootlet-foramen on its outer side (fig. 16). A single vibraculum in the axil of a bifurcation. Ovicells rather elongate, with numerous small pores which are not raised. Joints as in *S. securifera*, the chitinous tubes en échelon. Rootlets often with barbing thorns.

S. obtecta differs from *S. curvata* in having more spines, the number of which is very constant in the Siboga specimens, the proximal pair being stout and bifurcate; in the more elongate frontal avicularia; and particularly in the fact that these structures do not form a raised margin to the proximal border of the opesia. In most respects the Siboga specimens vary little. The bifurcate spines, which occasionally show a third tine between the two principal tines, are constant. The ovicells are rather more porous than in *S. curvata*. The scutum and the spines are jointed at the base, and the distal spines may have an articulation near the distal end.

The arrangement of the cavity of the scutum (fig. 17) is as in *S. curvata*, the main canal being broad and central, as noticed by HASWELL in his original description, passing into a tube running longitudinally at the outer border of the scutum, where it gives off recurrent caecal branches. HASWELL stated that there are no marginal spines, but these structures are easily overlooked in specimens in poor condition. In Miss THORNELY's specimen from Ceylon, the bifurcate spines are conspicuous, and the frontal avicularia of the two inner zooecia (F, G) of a bifurcation may have a mandible with a broadened distal end, bearing a spike at each corner; while in 108. Q enlarged frontal avicularia occur on the same two zooecia, but with simple, linear mandibles.

There appears to have been much confusion with regard to *S. obtecta* and *S. cervicornis*, the latter being, I think, identical with *S. diadema* Busk. The question is further complicated by the species which I describe below as *S. curvata*, and it is thus hardly possible to include all the records in reliable synonymies. HASWELL's description of *S. obtecta* was not accompanied by a figure, but I have found a specimen which I refer to his species among material which had formed part of his original collection. WATERS (1909) has moreover recorded (as *S. cervicornis*) a form from Queensland, the type-locality, which appears to belong to the present species, in the light of his description and of the figures given in his 1913 paper. I have not included the

citations of *S. obtecta* by HINCKS (1883, AMNH, 5; XI, p. 193) and MACGILLIVRAY (1886, PZV, XIII, p. 100), based on Victorian material; and it may be remarked that considerable differences exist in general between the Polyzoa of Queensland and those of Victoria. As represented in the British Museum, specimens from Victoria frequently possess the gigantic marginal avicularia described by these authors, in some cases having a conspicuously trifoliate rostrum and a mandible bearing three sharp distal spikes. The ovicells are much larger than in the Siboga species, and are broader than long, with small pores.

8. *Scrupocellaria curvata* n. sp. (Pl. XXVI, figs 11—15).

270. F. Stat. 60. Haingsisi, Samau Id, W. Timor, 0—36 M.
37. Q. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
Type. 299. D. Stat. 273. Jedan, Aru Is, 13 M.
194. E. Stat. 274. Off Jedan, Aru Is, 57 M.
228. B. Stat. 305. Solor Strait, E. of Flores, 113 M.
245. B. Stat. 310. Sumbawa, E., 73 M.
259. D. Stat. 318. Off Kangeang Id, N. E. of E. end of Java, 88 M.

Cambridge, Mus. Zool.: —

Singapore, New Harbour, 5—10 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.
BM Singapore, from a submarine cable, C. STEWART, Reg. Apr. 26, 1899.

British Museum: —

Torres Straits, Thursday Id, 82. 2. 23. 396—400.

Zoarium rather coarse, zooecia short and broad, the opesia occupying about two thirds of the front, with a distinct cryptocyst, which is much developed in old individuals. Oral spines inconspicuous except in young zooecia, usually 1 at each distal angle, occasionally a median one as well. Scutum extremely large, covering nearly the whole of the opesia, its stalk united with the opposite frontal avicularium, its distal edge raised and truncate, more or less concave, its proximal margin rounded; with a broad median cavity, passing into an external marginal tube, which gives off recurrent, caecal branches running transversely, parallel to the main cavity. Frontal avicularium moderate, the mandible shortly triangular (fig. 13), its rostrum lying on the inner side of the proximal end of the opesia, towards which it is directed; the basal portion extending in a curve (hence the trivial name) round the proximal margin of the opesia and ending in a tooth-like process, the margin thus appearing much elevated. Marginal avicularium minute, lying on the outer edge of the opesia, at its distal end, and overlying the vibraculum. Vibracula large, visible in frontal view, the rostrum (on the back of the branch) elongate and narrow (fig. 12); the rootlet-foramen lateral. A single vibraculum in the axil of a bifurcation. Ovicells porous. Bifurcation as in *S. securifera*, the chitinous tubes in overlapping laminae, arranged en échelon.

The very large scutum, with truncate distal margin and complicated arrangement of its cavity, is a characteristic feature of the present species, which is further distinguished by its large vibracula, with setae greatly exceeding the zooecia in length, and by the relation of the frontal avicularia to the proximal margin of the opesia.

The surface of the scutum is convex from side to side, its outer distal angle resting on

the edge of the opesia. While the exact details of its cavity are variable, its general method of branching is that indicated in the diagnosis. The frontal avicularia have a close resemblance to those of *S. securifera*, in which the external tooth-like process articulates with the scutum. The marginal avicularia are minute and partake in the formation of the edge of the opesia, as in the frontal avicularia. The seta of the vibraculum is very strong. The jointing is inconspicuous externally, but the chitinous tubes are extremely strong (figs 14, 15) and their lamination, en échelon, is even more conspicuous than in *S. securifera*. The ovicells are of moderate size, usually with pores round the margin, as seen in frontal view, but sometimes with small pores on the frontal surface as well. In a decalcified preparation, the stalk of the scutum is represented by a strong chitinous ring. I have not certainly found barb-like thorns on the rootlets. A strongly developed oral shelf occurs inside the opesia, which in old zooecia may be occluded in an iris-like manner, by an extension of the cryptocyst, at a low level, leaving only a small central perforation.

9. *Scrupocellaria longispinosa* n. sp. (Pl. XXV, figs 26—34).

Scrupocellaria cervicornis Hincks, 1883, AMNH, 5, XI, p. 194. Singapore or Philippines.

Type. 108. AI. Stat. 144. S. of Halmaheira (Djilolo), 45 M.
191. A. Stat. 274. Off Jedan, Aru Is, 57 M.
613. A. Stat. 310. Sumbawa, E., 73 M.
374. L. Locality not recorded.

Cambridge, Mus. Zool.: —

BM Singapore, 5—10 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.

Zoarium rather delicate, the zooecia elongate, with an opesia occupying not much more than half of the front, a slight cryptocyst proximally. Spines usually 6, of which 3 are external, 1 distal and 2 internal, the larger ones jointed at the base. The distal and the first external spines are small. The second external is usually very long and strong, but does not appear to be bifurcate. The third external arises from its base, and is delicate, short and typically bifurcate or even trifurcate (figs 28, 30), with slender, narrow tines. The first or distal inner spine is small and simple, the second spine of this side long and sometimes bifurcate. Scutum variable, sometimes filling nearly the whole of the opesia, but usually much less, its two lobes about equal and rounded, its principal central cavity opening into a marginal space, which gives off recurrent caecal branches, sometimes hardly developed (figs 27, 34). Frontal avicularia often wanting, sometimes small and with simple mandibles; and, in other cases, mostly on the axillary zooecia, subcylindrical, much elevated, of considerable size (fig. 26), the opesia at the summit of the cylinder, the mandible directed basally and proximally or transversely, and prolonged into 3 or 4 long, acute points (fig. 29). Marginal avicularia (fig. 30) constantly present, very small, often concealed by the large outer spine in frontal view. Vibracula short and broad, visible in frontal view, the setal groove on the basal surface oblique (fig. 31), the seta exceeding a zooecium in length, its tip hooked. A single vibraculum in the axil of a bifurcation. Rootlets often with very strong barbing thorns. At the bifurcation the chitinous joint traverses the proximal end of the opesia of the outer zooecium. Ovicells (one or two in 613. A, not well shown) rather long, depressed frontally, with a few pores.

C. longispinosa is distinguished by the arrangement of its spines, some of which are very long, by its short opesia, by the complicated mandibles of the enlarged frontal avicularia (if present), and by the fact that the joint traverses the opesia of the outer zooecium. The scutum (figs 32—34) has recurrent branches, sometimes vestigial, sometimes (fig. 33) broad and in close lateral contact so as to leave no interspaces, and arising from a marginal zone which may occupy as much as a third of the width of the scutum. The peculiar, cylindrical frontal avicularia of this species have been described by HINCKS.

S. annectens, as understood by Miss PHILIPPS (1899, WZR, pp. 439, 442), from New Britain, resembles *S. longispinosa* in the number of its outer spines, but probably belongs to a different species, as indicated by the nearly transverse vibracular groove, shown in the rather poor specimen mounted by Miss PHILIPPS for the Cambridge collection.

10. *Scrupocellaria spatulata* (D'Orb.). (Pl. XXVI, figs 1—10).

Crisia pilosa Audouin, 1826, EPS, p. 241; 1828, p. 71. SAVIGNY, DE, Pl. XII, figs 1^1—1^7.
Scrupocellaria pilosa Waters, 1913, BEA, p. 478, Pl. LXVIII, figs 3, 4. British E. Africa.
(?) *Scrupocellaria pilosa* Thornely, 1912, PIOS, p. 139. Indian Ocean.
(?) *Scrupocellaria pilosa* Robertson, 1921, BBB, p. 36. Ceylon.
Cellularia spatulata D'Orbigny, 1851, PFTC, p. 50.
Cellularia pusilla Smitt, 1872, KVAH, X, 11, p. 13, Pl. V, figs 32—34. Florida.
Scrupocellaria cervicornis Kirkpatrick, 1890, TS, p. 611. Torres Straits.
Scrupocellaria cervicornis Marcus, 1922, AI, p. 425, Pl. XXIV, figs 3*a*, *b*. Aru Is.
(?) *Scrupocellaria cervicornis* MacGillivray, 1886, PZV, XIII, p. 101, Pl. 126, figs 6—6*b*, 7. Victoria.
Scrupocellaria scrupea Philipps, 1899, WZR, pp. 439, 442. Lifu, Loyalty Is.

37. J. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
456. A. Stat. 78. Borneo Bank, Strait of Makassar, 34 M.
57. T, Z, ZA. Stat. 80. Borneo Bank, Strait of Makassar. 40—50 M.
362. E. Stat. 89. Kaniungan Ketjil, E. Borneo, reef.
467. F. Stat. 91. Muaras Reef, E. Borneo, 0—54 M.
482. D. Stat. 116. Kwandang Bay, N. Celebes, 72 M.
92. I. Stat. 117. Kwandang Bay, N. Celebes, 80 M.
493. B. Stat. 153. Waigeu Id, N., 141 M.
117. C. Stat. 164. W. of N. end of New Guinea, 32 M.
299. I. Stat. 273. Jedan, Aru Is, 13 M.
216. B. Stat. 285. Timor, E., S. coast, 34 M.

Cambridge, Mus. Zool.: —

BM Lifu, Loyalty Is, as *S. scrupea* (Miss PHILIPPS), A. WILLEY, Reg. Mar. 1, 1898.
BM Japan, 7. V, 30 fath., A. OWSTON, Reg. June 23, 1902.

British Museum: —

Madagascar, Admiral BELCHER (undetermined), 42. 12. 2. 91.
Torres Straits, as *S. cervicornis* (R. KIRKPATRICK), 90. 3. 24. 56.

Zoarium delicate, zooecia elongate, the opesia occupying less or not much more than half the front, sometimes with a distinct, narrow cryptocyst. Spines 2 or 3 external, 1 or 2 distal, 1 or 2 internal, not bifurcate (in the present material), some jointed at the base. Scutum moderate or small, originating on the proximal side of the middle of the opesia, which it does not fill; its two halves equal or the distal lobe the larger, its cavity variable, sometimes with recurrent,

caecal branches given off from a marginal cavity. Frontal avicularia small, elevated and compressed, often reclining on the edge of the opesia of the adjacent zooecium, the rostrum and mandible narrow. Marginal avicularia mostly small, more or less projecting from the lateral edge of the branch; occasionally very large, the rostrum widening and trilobed at the end, the mandible shortly triangular proximally, the enlarged distal end with a median and two lateral spikes, or a single median spike. Vibraculum moderate or small, appearing in frontal view beyond the marginal avicularium, but concealed in fertile zooecia; the rostrum (on the basal side of the branch) narrow and short, oblique, the rootlet-foramen at the (actual) proximal end; the seta delicate and not very long. A single vibraculum in the axil of the bifurcation (fig. 6), the joints conspicuous and traversing the outer zooecium on the proximal side of its opesia. Rootlets with strong barbing thorns. Ovicells porous.

Waters (1913) has pointed out that *Cellularia pilosa* Pallas (1766, EZ, p. 72), from the Mediterranean, is unrecognisable; and it cannot be ascertained whether Audouin's determination and that of Lamouroux (mentioned by Audouin) were correct. It thus seems best to accept D'Orbigny's name, which was expressly founded on Savigny's figures. Smitt's figures of *S. pusilla* agree well with the Siboga specimens in most characters, particularly in the position of the joint and of the vibracula. *S. cornigera* (Pourtales), recorded by Smitt in the same memoir (p. 14), seems to be closely allied to *S. pusilla*. *S. wasinensis* Waters (1913, p. 479) resembles *S. spatulata* in having occasional enlarged marginal avicularia; but its other characters seem to indicate that it is not identical with it. *S. pilosa* Busk (1884, Chall., p. 24), from Tristan da Cunha, possesses two axillary vibracula, and is not referable to the present species.

S. spatulata is characterised by its remarkable, enlarged marginal avicularia, which occur in small numbers in most of the specimens, but not in all. It is distinguished from *S. longispinosa* by the position of the joint, which is on the proximal side of the opesia of the outer zooecium (fig. 4).

The enlarged marginal avicularia stand out prominently from the sides of the zooecia (fig. 10). The rostrum is usually trilobed distally, and each lobe may project as a strong, independent hook. An avicularium of this type occurs in the specimen from Lifu recorded by Miss Philipps as *S. scrupea*. In many of the specimens the mandible has the form shown in fig. 5, the widened distal end having three long, strongly recurved, linear spikes. In 37. J, which was at first supposed to be a distinct species, the mandible (figs 1, 9) widens in a spatulate manner, and is provided with only one, median spike. The scutum is variable. In 299. I (figs 3, 10) there is a distinct central canal, which opens into a broad marginal space giving off recurrent caecal branches. In 37. J (fig. 2, 4), the central canal is indicated, usually defined by two projecting points, but the broad marginal space is simple, without recurrent branches. In 57. T (figs 7, 8) the condition is even less complicated.

The ovicells are usually of the form shown in fig. 10 (299. I), with uniformly scattered pores. In 37. J (fig. 4) the frontal surface is mostly imperforate, outlined distally and laterally by a semicircular ridge, on which is a row of pores, each carried by a short, tubular portion of the wall of the ovicell. 37. J differs from 299. I in its large marginal avicularia (figs 1, 9), in its scuta and in its ovicells. It resembles the remaining specimens so closely, however, in general characters that I think it belongs to the same species.

The arrangement of the spines is practically constant. The vibracula (fig. 6) vary to some

extent, being larger in some specimens than in others. They all seem to agree in the short, narrow, oblique rostrum, and in the position of the rootlet-foramen. The joints are commonly extremely conspicuous, as in fig. 4, but the calcareous matter is not always absorbed so much as in this specimen. In 37. J I have observed two calcareous rings, en échelon, but the number is smaller than in the more robust species, where greater strength is required.

92. I is interesting as showing the characters of a young colony, which is growing on *Bugula subglobosa* (see that species, slide 92. E[1]). The ancestrula is urceolate, the proximal part ovoid, a little constricted before expanding into the short distal portion, which carries the terminal, slightly oblique, subcircular opesia, which is surrounded by about 10 spines. It gives rise to the first two alternating zooecia, which produce attaching rootlets from their extreme proximal ends. The more distal member of this pair, corresponding with A in fig. 6, has a rootlet arising in the normal way from its vibraculum, and it has produced two distal successors, one of which is axillary. Up to the bifurcation, and even beyond it, each blastozooid has seven spines, one standing vertically on either side of the orifice, and the other five evenly spaced out along the distal margin. In the youngest zooecia the adult condition is reached, the spines being grouped at the two sides, 3 on the outer side, 2 on the inner, and 2 distally, near the outer spines. The blastozooids, of which there are only 11, have normal scuta, marginal avicularia and vibracula, but frontal avicularia and enlarged marginal avicularia have not yet appeared. The spines are jointed at the base and some are very long.

6. **Canda** Lamx.

Canda Lamouroux, 1816, PCF, p. 131; — 1821, EM, p. 5.
Canda Levinsen, 1909, MSSB, p. 141; et auctt.
Monotypical. Genotype, *Canda arachnoides* Lamx., 1816.

Zoarium usually with the branches in a single plane, biserial, jointed or unjointed, the zooecia facing obliquely outwards from a median frontal keel. Aperture occupying the entire frontal surface, the opesia considerably reduced by the development of a proximal and lateral cryptocyst, and oval, or triangular with an acute point proximally. Spines generally 1—1, as a rule small. Scutum present or absent. Frontal avicularia present or absent, on the median keel, sometimes only at the bifurcations, typically occurring at the distal end of the ovicell, where they may be reduced to vestiges. Marginal avicularia wanting. Vibracula passing obliquely across the basal surface, the setae without serrations and usually strongly curved; giving off rootlets which have the ordinary character at the proximal end of the zoarium, forming cross-connexions more distally. Two vibracula in the axil. Ovicells large, developed on only a few of the zooecia, directed obliquely inwards, occurring either singly or in small groups of 2—4 or more, and then forming a longitudinal line down the middle of the branch, alternately produced by the zooecia of the two sides. Frontal surface of ovicell occupied by a large fenestra, where the ectooecium fails to develop; a similar fenestra, of large size, distally, either remaining in this condition, or giving rise to a large avicularium forming a cap on the ovicell.

The distribution is remarkable; one group occurring off the south and east coasts of Australia, extending to the Malay Archipelago and to the Indian and Pacific Oceans; and another group being found in the Caribbean Sea and off the Atlantic coasts of N. and S. America.

Although Busk (1852, BMC, p. 26) regarded the cross-connexions between the branches as unimportant, I consider them a highly characteristic feature of the genus. Satisfactory evidence has not been obtained as to their mode of development, but I think that each of these tubes must be considered, as stated by Busk, a modified rootlet developed from a single vibraculum, and not as the joint product of two vibracula on adjacent branches. But it appears that each rootlet thus formed is induced, by some attractive force in the adjacent branch, to attach itself to another vibraculum, usually immediately opposite that from which it arises. As the tube thus ends in a vibraculum at each end, it is often difficult to decide which is its base and which is its insertion. In other instances the tube extends from the rootlet-foramen on one branch to a more complicated insertion, which seems to be very intimate, on a vibraculum of the other branch. A rootlet of this kind may pass completely across the second branch, and attach itself to an outer vibraculum of a third branch, instead of to an inner vibraculum as in typical instances.

The bifurcation (text-fig. 17) is a modification of the type found in *Menipea* (Harmer, 1923, JLS, XXXV, p. 328); the joint, if present, traversing the inner opesia in the axil. The inner zooecia, F, G, are provided with polypides, which later atrophy and are not regenerated, as ascertained in the Victorian specimen of *C. arachnoides* figured; and there is at first no trace of a joint. The wall of the zooecium produces a strong, chitinous, ∩-shaped tube, which is vertical and longitudinal, with its convex surface directed frontally. This tube is conspicuous in F and G, in Canada balsam preparations, as two circles, optical sections of the two limbs of the ∩. The actual joint passes between the two limbs, but in the outer row it is seen, in frontal view, just distally to the orifices of C and D. In basal view it traverses K and J in such a way as to leave part of each of these zooecia on the proximal side of the joint. This mode of jointing has been described, in some of its features, by Waters (1887, AMNH, 5, XX, p. 89, Pl. IV, fig. 7; — 1913, BEA, p. 473, Pl. LXIX, fig. 6) and by Levinsen (1909, MSSB, p. 142). In the three Siboga species a chitinous tube (not present in the young bifurcation) appears in the inner basal zooecium of one branch only, and is narrower and much straighter than in *C. arachnoides*. In an older state the neighbouring outer zooecium of the same branch may also develop a chitinous tube. In *C. foliifera*, an internode is sometimes jointed across its middle, where a single zooecium may produce a chitinous tube, without the occurrence of a bifurcation.

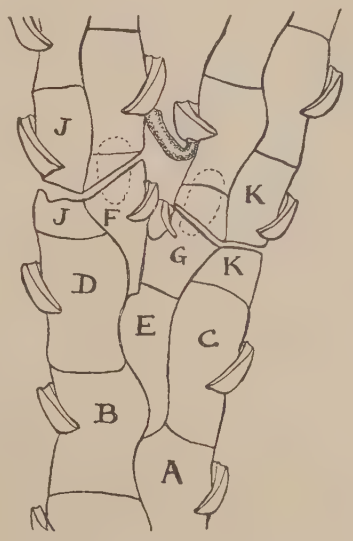

Fig. 17. — *Canda arachnoides* (Victoria, Mus. Cambridge (BM), Reg. May 13, 1899). Bifurcation. The joints traverse the opesiae of the inner zooecia F and G. A connecting tube between two vibracula occurs on the distal side of the bifurcation. Obj. A, reduced 3/4.

The absence of marginal avicularia appears to be a normal feature of the genus. The frontal avicularia may be conspicuous, as in *C. arachnoides* and *C. clypeata*, where they occur on the ordinary zooecia, and in *C. pecten*, where they are confined to the bifurcations. In some other species they are found only on the distal side of the ovicell, where a large fenestra in the wall corresponds with the base of the avicularium, which may, however, remain vestigial, the distal ovicell-fenestra being then obvious. The restricted number of ovicells is in strong contrast with their profuse development in most of the genera of Scrupocellariidae.

The scutum is apparently present or wanting within the limits of a single species, as in *C. pecten*. The species described by LEVINSEN (1909, p. 142) as *C. caraibica* may be merely a variety of *C. retiformis* Pourtales (cf. SMITT, 1872, KVAH, X, 11, p. 16), from which it is distinguished principally by the want of a scutum. OSBURN, however (1914, CIW, 182, p. 192), considers it distinct. Both forms occur in practically the same area, and LEVINSEN indicated that *C. caraibica* is possibly identical with *C. simplex* Busk (1884, Chall., p. 26). *C. tenuis* MacGillivray, 1885 (see MACGILLIVRAY, 1887, PZV, XIV, p. 139), which LEVINSEN gave also as a doubtful synonym of *C. caraibica*, is certainly distinct; and is characterised by the prominent, narrow avicularia, which occur on the ordinary zooecia. MAPLESTONE (1882, PRSV, XVIII, p. 50), who described *C. arachnoides* as bright orange in life, recorded 16 tentacles in this species, a number with which WATERS (1913, p. 481) agrees. In the same paper (p. 474) WATERS states that the setae of the vibracula are serrate, but I have found no trace of this in any species.

Canda was established by LAMOUROUX for a single species, *C. arachnoides*, from Timor. In his original account, fig. 6*a* (Pl. 11), the colony unmagnified, barely shows the characteristic cross-connexions between the branches; but these are satisfactorily indicated in his later work (1821), where Pl. LXIV, fig. 19 seems to be a new drawing of the original specimen. The British Museum possesses a specimen of this species, from the BUSK Collection (99. 7. 1. 6603), labelled by LAMOUROUX as from Timor, the type-locality, and from his original collection, now at Caen. This shows all the characteristic features of the species described by BUSK (1852, BMC, p. 26) and others as *C. arachnoides*; and in particular the absence of a scutum, the presence of a row of conspicuous frontal avicularia, and the mode of jointing. Although the Siboga obtained two species of *Canda* off Timor, or in its immediate neighbourhood (Stations 60, 220, 282, 301), *C. arachnoides* is wanting in these and in all the other dredgings.

Key to the Siboga species of *Canda*.

1	Opesia rounded proximally.	2
	Opesia acutely pointed proximally	3
2	Scutum leaf-like, originating by a broad stalk at the proximal end of the opesia, the proximal lobe undeveloped; frontal avicularia usually wanting, except on the ovicells	1. *C. foliifera.*
	Scutum with distinct proximal and distal lobes, originating by a narrow stalk, separated by a distinct interval from the proximal end of the opesia; large frontal avicularia on some of the ordinary zooecia, as well as on the ovicells	2. *C. clypeata.*
3	Scutum wanting; a large avicularium at the base of each branch at the bifurcation	3. *C. pecten.*
	Scutum present; large avicularia as in the typical form . . .	3a. *C. pecten*, var. *scutata.*

1. *C. foliifera* n. sp. (Pl. XXVI, fig. 21—23).

Caberea retiformis Thornely, 1905, PGM, p. 109. Ceylon.
(?) *Canda retiformis* Thornely, 1912, PIOS, p. 141. Indian Ocean (Seychelles, etc.).
Canda retiformis Waters, 1913, BEA, p. 479, Pl. LXIX, figs 1, 2, 6. Zanzibar, British E. Africa.

651. B. Stat. 65a. Tanah Djampeah, between Flores and Celebes, 120—400 M.
488. F. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M.
108. K. Stat. 144. S. of Halmaheira (Djilolo), 45 M.
120. A. Stat. 164. W. of N. end of New Guinea, 32 M.
528. B. Stat. 220. Binongka Id, S. E. of Celebes, 55 M.
279. B. Stat. 250. Kur Id, Kei Is, 20—45 M.
204. A. Stat. 282. Timor, E., 27—54 M.
218. A. Stat. 301. Rotti Id, E., S. W. of Timor, 22—45 M.
Type. 224. A. Stat. 305. Solor Strait, E. of Flores, 113 M.

Cambridge, Mus. Zool.: —

BM Torres Straits, 144, 15—20 fath., A. C. HADDON, Reg. Feb. 24, 1898.
BM Ceylon, Miss L. R. THORNELY (as *C. retiformis*), Reg. Apr. 25, 1906, 6.

British Museum: —

Dammer Id, Banda Sea (as *Canda* sp.), 92. 4. 14. 6.
Amirante Group (Indian Ocean), 'Alert' Collection (as *C. retiformis*). 82. 10. 18. 5—10.

Branches relatively coarse. Zooecia less than twice as long as wide, more or less hexagonal. Cryptocyst thick, minutely granular, greatly developed proximally. Opesia slightly wider distally, rounded proximally. Spines 1—1, the inner spine bifurcate on fertile zooecia. Scutum (fig. 21) arising by a thick stalk, close to the proximal end of the opesia, its proximal lobe wanting or hardly indicated, the remainder leaf-like, asymmetrically lanceolate, acutely pointed distally. Avicularia usually wanting except on the distal side of an ovicell, where the frontal avicularium is represented, usually by a vestige. Vibracula (the articular end) visible in frontal view at the edge of the branch, running obliquely across the basal surface in a curve, concave distally and directed proximally, the end of the rostrum passing the suture between two zooecia (fig. 23). Rootlet-foramen conspicuous. Ovicells (figs 21, 22), large, oblique, usually occurring in groups of 2—4, belonging alternately to opposite sides of the branch, the ectooecium practically wanting on the frontal surface, which is thus occupied by a large fenestra, its edge generally thickened; the distal wall with a similar fenestra, on which is an avicularium, usually vestigial.

C. foliifera is of robust growth, its zooecia short and wide. The frontal surface is strongly convex, the characteristic scuta having the same convexity, their distal point more or less raised above the general surface. The scuta vary in form, being usually broad, as in fig. 21, not infrequently with a narrow distal end, which may simulate a spine (Ceylon specimen). Their origin from the proximal end of the opesia, by a broad stalk, is characteristic of this species, which is usually distinguished by the absence of avicularia (with the exceptions noted) and by the large ovicells, arranged in small groups. Except for slight variations in the scuta, the characters appear to be very constant. The Ceylon specimen has small frontal avicularia on the ordinary zooecia, as described by Miss THORNELY (1905).

2. *Canda clypeata* (Hasw.). Pl. XXVI. figs. 19, 20).

Scrupocellaria clypeata Haswell, 1880, PQC, p. 37, Pl. I, fig. 6. Queensland, Holborn Id, 20 fath.
Canda retiformis (pars) Philipps, 1899, WZR, pp. 439, 441, Pl. XLII, fig. 1. Lifu, Loyalty Is, 30—40 fath.

282. A. Stat. 43. Pulu Sarassa, Postillon Is, 0—36 M.
270. E. Stat. 60. Haingsisi, Samau Id, W. Timor, 0—36 M.
177. A. Stat. 257. Kei Is, 0—52 M.

Cambridge, Mus. Zool.: —.

BM Lifu, Loyalty Is, 30—40 fath., Miss E. G. PHILIPPS (as *C. retiformis*), A. WILLEY Coll., Reg. Mar. 1, 1898.
Queensland, from W. A. HASWELL's collection (unnamed), Australian Museum, Reg. Oct. 23, 1899.

British Museum: —

Queensland, *Canda* (*Scrupocellaria*) *clypeata*, paratype, Australian Museum, 10. 6. 16. 1.
Tizard Bank, China Sea, 27 fath. (as *Canda* sp.), 89. 8. 21. 125.

Branches relatively narrow. Zooecia narrow, at least twice as long as wide. Cryptocyst and opesia as in *C. foliifera*. Spines 1—1. Scutum arising by a narrow stalk, in the proximal half of the opesia, often not far from the middle, the proximal lobe distinct but short, frequently truncate proximally and angulated at its inner corner; the distal lobe much longer and narrow. Frontal avicularia moderately common, on the ordinary zooecia and on the ovicells, much raised; with triangular, spiked mandibles (fig. 20) becoming narrower distally, the proximal edge of the rostrum denticulate. Vibracula as in *C. foliifera*, the seta curved and relatively broad (fig. 20). Ovicells surmounted by a large avicularium. Rootlets sometimes with barbing thorns.

C. clypeata has much resemblance to *C. foliifera*, from which it can be distinguished by its longer and narrower zooecia, by the form of its scutum, as described and figured by HASWELL, and by the occurrence of large frontal avicularia (fig. 19). Ovicells are not common. In 177. A they occur in pairs, one belonging to each side. They are, as usual, oblique, so that the two lie in a longitudinal line, at the middle of the branch. The frontal fenestra is considerably wider than long, and is shorter on the median than on the outer side. The distal fenestra is concealed by a large avicularium, the rostrum of which is in the middle line of the branch and is directed distally, its shape and that of the mandible agreeing with the corresponding parts in the ordinary frontal avicularia. The avicularium is of the same diameter as the ovicell at its base, and forms a conical cap on it, its apex represented by the tip of the rostrum.

There has been much confusion with regard to *C. retiformis* Pourtales (1867, BMCZH, I, p. 110), described from off Havana, 270 fath., and later by SMITT (1872, KVAH, X, 11, p. 16, Pl. V, figs 43—46), who obtained his material from POURTALES but gives the depth as 68 and 270 fath. All three of the Siboga species have been described by one author or another as *C. retiformis*; and there are references to this species, from the Indian Ocean, in the works of other authors, accompanied by insufficient information. *C. clypeata* has undoubted resemblances to *C. retiformis* in the characters of its opesia and scutum. From the examination of American specimens in the British Museum, mostly from the John Adams Bank, off Brazil, I think the two species can be distinguished. In POURTALES' species the scutum arises practically at the middle of the opesia, and its proximal and distal lobes are equal. The whole lateral and distal margins of the zooecia are uniformly raised, so that the zooecia have a very regular appearance. In agreement with SMITT, I have found no frontal avicularia (except on the ovicells), in this material. In *C. clypeata* the scutum arises more proximally, and the distal lobe is considerably longer than the proximal lobe; while the zooecia have not the same regularity of outline as in the other species. The most important differential feature of *C. clypeata* is the occurrence of large frontal avicularia on the ordinary zooecia as well as on the ovicells. I do not agree with WATERS (1909, SRS, p. 165) that the presence of frontal avicularia is of little importance.

3. *Canda pecten* Thornely (Pl. XXVI, figs 25—28).

Canda pecten Thornely, 1907, MPIM, p. 182, text-fig. 2. Coast of Cheduba (Burma), 28—30 fath. and N. of Andaman Is, 41 fath.

20. H. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
37. O. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
57. M. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
459. B. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
249. F. Stat. 310. Sumbawa, E., 73 M.
556. B. Stat. 322. Bawean Id, S., Java Sea, 32 M.
374. I. Locality not recorded.

Cambridge, Mus. Zool.: —

BM Japan, 7. U, 30 fath., A. Owston, Reg. June 23, 1902.

Zooecia elongate and narrow, with parallel sides. Cryptocyst thin, smooth and greatly developed proximally. Opesia elongate, triangular, broad distally, acutely pointed proximally; its sides asymmetrical, the inner edge parallel with the wall of the zooecium and close to it, the outer passing obliquely inwards from the broad distal end. Spines 1—1, the external commonly wanting but sometimes reaching half the length of the zooecium, often much shorter; both spines occasionally bifurcate, especially in fertile zooecia. Scutum wanting. A greatly enlarged frontal avicularium at the base of each branch at a bifurcation (figs 25, 28), considerably raised, the rostrum and mandible (fig. 27, R. and middle) directed proximally and inwards. Avicularia otherwise wanting, except on the distal side of an ovicell, where the avicularium is vestigial. Articular end of the vibraculum visible in frontal view at the edge of the branch, the rostrum (fig. 26) with a slight distal concavity, reaching a little beyond the suture separating its own zooecium from its lateral neighbour; rootlet-foramen conspicuous, seta curved (fig. 27, L.); ovicells (fig. 28) extremely oblique, relatively small, directed inwards from the orifice; the ectooecium more developed than in *C. foliifera*, so that the frontal fenestra does not occupy the entire surface; the distal wall with a similar fenestra, corresponding with the vestigial avicularium. Rootlets forming the usual connecting tubes between adjacent branches, those which arise from the proximal parts of the colony not forming these connexions, but having the character of ordinary rootlets, and furnished with recurved barbs, as in species of *Scrupocellaria*.

3a. *Canda pecten* var. *scutata*, nov. (Pl. XXVI, fig. 24).

Canda retiformis (pars) Philipps, 1899, WZR, pp. 439, 441. Lifu, Loyalty Is, 30—40 fath.

120. B. Stat. 164. W. of N. end of New Guinea, 32 M.
Type of var. 181. A. Stat. 260. Kei Is, 90 M.

Cambridge, Mus. Zool.: —

Lifu, Loyalty Is, Miss E. G. Philipps (as *C. retiformis*), A. Willey Coll., Reg. Mar. 1, 1898.

British Museum: —

Lifu, same collection, 00. 6. 26. 3.
Tizard Bank, China Sea, 27 fath. (as *Canda* sp.), 89. 8. 21. 109.

Resembling the typical form in all respects except in being of more slender habit, and in possessing small T-shaped scuta.

This species and its variety are remarkable for the high specialisation of the avicularia, which, except for the vestiges connected with the ovicells, are restricted to a single pair at a bifurcation (sometimes wanting). These may be regarded as the frontal avicularia of zooecia J and K, the first outer zooecia of the two branches. As described by Miss THORNELY, the outer edge of the rostrum is serrated (fig. 25). The mandibles (fig. 27) of these avicularia are very broad, but end in a fine, recurved point. The setae (fig. 27, L.) of the vibracula are also broadened and are strongly curved. When brought round to the frontal surface they lie edgeways, with the concavity distally, just on the distal side of the orifice of the preceding zooecium. The occurrence of a variety with scuta is of interest.

The ovicells occur in groups of three or more; and, in consequence of their oblique direction, they appear to form an additional, median row between the two series of zooecia.

C. fossilis, a Victorian fossil described by WATERS (1881, QJGS, XXXVII, p. 322, Pl. XVI, figs 51, 52) resembles *C. pecten* in the shape of its opesia.

Fam. 2. EUOPLOZOIDAE fam. nov.

With the characters of *Euoplozoum*, the only known genus.

Euoplozoum [1]) Harm.

Cellularia (pars) Busk, 1884, Chall., pp. 15, 16.
Euoplozoum Harmer, 1923, JLS, XXXV, p. 308.
Monotypical. Genotype, *Cellularia cirrata* Busk, 1884.

Zoarium unilaminar, erect, attached by a basal tuft of rootlets. Branches jointed, biserial, the zooecia large and obliquely alternating, all facing in the same direction, their proximal portions narrow, their distal portions much expanded. Frontal membrane occupying the entire surface of the expanded portion, the basal wall very convex. Each zooecium is traversed by two oblique joints, which divide it into three sections, the proximal one very short. Strong *flexor zooecii* muscles present, their contraction inflecting the branches in a frontal direction. Marginal avicularia sessile on the outer distal borders of the zooecia; much raised frontal avicularia of gigantic size arising near the inner borders of a few zooecia. Ovicells very large, hyperstomial.

Euoplozoum possesses characters which appear to connect it with the Scrupocellariidae, the Epistomiidae and the Bicellariellidae, and it seems necessary to propose a new Family for its reception. It resembles the Scrupocellariidae in possessing sessile marginal avicularia, constantly present, and in having frontal avicularia which are apparently not jointed at the base.

The possession of muscles which obviously act as flexors of the entire zooecium suggests an affinity to *Kinetoskias* (Bicellariellidae), as remarked by Miss ROBERTSON (ref. below), who also called attention to the resemblance of the smaller avicularia to the marginal avicularia of Scrupocellariidae. It should be remembered, however, that flexor muscles of the zooecia are also found in *Mimosella* (this Report, Part I, 1915, p. 78), a Ctenostome which cannot be regarded

1) εὔοπλος, well armed.

as related to either of the Cheilostomes under consideration; and it is possible that they have been independently evolved in *Euoplozoum* and *Kinetoskias*. Sessile marginal avicularia are not found in the Bicellariellidae, but the gigantic frontal avicularia of *Euoplozoum*, even though not jointed at the base, resemble the pedunculate avicularia of that Family. A division of the zooecia into three sections is also found in certain Bicellariellidae (*Bicellariella*, *Caulibugula*).

The dimorphism of the avicularia found in *Euoplozoum* is closely paralleled in the Epistomiidae, which this genus resembles in having zooecia similarly divided into three sections, by means of two joints traversing every zooecium; one near the middle and one near the proximal end. The construction of the zoarium is widely different, however, in the two Families, and the Epistomiidae are not known to possess any trace of the characteristic *flexor zooecii* muscles and hyperstomial ovicells of *Euoplozoum*.

1. *Euoplozoum cirratum* (Busk). (Pl. XXX, figs 1—4).

Cellularia cirrata Busk, 1884, Chall., p. 17, Pl. II, figs 4—4*b*. Amboina, 1425 fath.
Kinetoskias arabianensis Robertson, 1921, BBB, p. 39, text-fig. 3, A—D. Arabian Sea, 931 fath.
Euoplozoum cirratum Harmer, op. cit., pp. 308, 326, Pl. XVI, fig. 6 (bifurcation).

526. B. Stat. 211. S. of Celebes, 1158 M.
536. B. Stat. 227. Banda Sea, S. of W. end of Ceram, 2081 M.

Characters as in the genus. Main rootlet swelling into a bulb-like enlargement. Branches capable of being strongly inflected by the contraction of *flexor zooecii* muscles; traversed by alternating oblique joints corresponding in number with the zooecia, each zooecium traversed by two joints. Basal walls of zooecia composed of numerous platelets, producing an appearance like frosted glass. A tooth-like process at the distal end of the zooecium, near the frontal surface. Spines and scutum wanting. Marginal avicularia constantly present, rather large; the rare frontal avicularia much larger, both kinds with a more or less aquiline beak. Ovicells globose, extremely large, wider than long, obliquely situated, occurring in restricted numbers; the opercula of the fertile zooecia much broader than those of the others.

This very remarkable species was first obtained by the Challenger; and Busk, who did not discover the frontal avicularia or the *flexor zooecii* muscles, thought that its peculiarities might justify the erection of a new genus. Miss Robertson described the same species, also in deep water, from the Arabian Sea. She found both kinds of avicularia and the *flexor zooecii*, from the presence of which she included the species in *Kinetoskias*. Although she proposed a new trivial name, she suggested that it might be identical with *C. cirrata* Busk. She found only a single, injured ovicell.

Gigantic frontal avicularia have been found by me in the unmounted part of the type-material of *Cellularia cirrata* in the British Museum. In this feature, as in all other important respects, the Siboga specimens agree with the type.

536. B consisted of several small fragments, with stalks giving off basally a number of fine, branching rootlets, which were attached to the Foraminifera of the ooze. One or two are young colonies, in which the proximal zooecium is prolonged into a main rootlet, dilated almost at once into a large pear-shaped bulb (fig. 1), which bifurcates at its proximal end and thus forms the commencement of the system of rootlets. The bulb probably serves to increase the

firmness of the attachment to the ooze. The proximal zooecium, which is presumably the ancestrula, gives rise to two distal successors, and these to others, all containing remarkably strong *flexor zooecii* muscles. Remains of a polypide are visible in the fourth zooecium, but the first three no longer contain a polypide. The stalk formed by these zooecia reaches a length of 100 mm. in 526. B, and passes into a branching colony composed of the large, alternating zooecia. Although really biserial, the branches appear at first sight uniserial, owing to the fact that the expanded parts of the zooecia overlap but slightly.

Each zooecium consists of three parts; — the third or distal section (fig. 2, *c*), expanded and containing the polypide; a narrower second section (*b*) more proximally; and a short and wide first section (*a*) which unites the zooecium to its predecessor in the same longitudinal row. In frontal view (fig. 3), the third or principal section is nearly straight on its external border, and strongly curved on the median border. It is rather narrower distally, where it has a rounded termination, and is obliquely truncate proximally, along a line corresponding with the second or distal joint which traverses each zooecium. The lateral margins are more or less raised and vertical, and the median raised edge is everted. The whole of the region thus outlined is occupied by the frontal membrane, which extends, not limited by a raised margin, along a part of the second section, on its outer and frontal surfaces.

The operculum is nearly terminal, and has a strong submarginal sclerite, prolonged basally, on each side, into a projection for the insertion of the occlusor muscle. The polypide is entirely confined to the third section; its tentacles, of which there seem to be about 22, lying on the external side of the alimentary canal. At the distal end of the zooecium, slightly on the basal side of the raised margin, a strong tooth-like projection (fig. 3, *t*) is given off, but is wanting in the axillary zooecia of the bifurcations. In most cases the tooth is on the external side of the middle line and is directed outwards, but it may be vestigial, in varying degrees. The zooecia A, B and C have the tooth (t^1) directed inwards, in such a way as to clasp the first section of the next zooecium in the same longitudinal row.

The second section of the zooecium (fig. 2, *b*) is terminated at each end by a straight joint, the lines of the two joints being oblique and converging towards the external side. This section is accordingly short externally and long medianly. The first section, which is not always easily seen, is a foot-like cavity, lying between the proximal joint and the preceding zooecium. It will thus be seen that each of the two joints which traverse every zooecium is formed principally by a zooecium of one side of the branch and is completed by a smaller contribution from a zooecium of the other side (fig. 3). On the frontal side the joints are only virtual, the bending of this surface being rendered possible by the membranous nature of its wall. The actual joints are on the basal surface, which is highly calcified, as a large number of small, irregular areas which give the wall the appearance of frosted glass (fig. 2). Along the joint-lines the calcareous substance is interrupted by short, membranous regions. The spirit-material shows that the joints are important, since most of the zooecia are strongly inflected, particularly at the ends of the branches, where the zooecia are curled in, in a manner suggestive of a tightly closed fist. The well armoured basal surfaces are here turned outwards, the more delicate frontal membranes being concealed in the interior of the aggregated mass of zooecia.

The mechanism by which flexion is accomplished is provided by the muscles to which

Miss Robertson called attention. Two of these muscles occur, both originating on the basal wall. The larger (fig. 3, *f. m.*[1]) lies on the median side, basally to the alimentary canal, its fibres originating from a considerable area of the basal wall, thence converging to the proximal end of the frontal membrane, into which they are inserted along a line of moderate length, distally to the second joint of the zooecium. The second muscle (*f. m.*[2]) originates more externally and is shorter than the first, its fibres having a slightly more vertical direction. It is inserted into the frontal membrane on the outer side of the insertion of *f. m.*[1] and along a line not quite parallel to it. In *f. m.*[2] each fibre has a stained spherule, which appears to be a nucleus, at the middle of its length, but this does not seem to be the case in the fibres of *f. m.*[1]; — a curious difference, which suggests a different mode of action of the two muscles. While both appear to be capable of causing and regulating the flexion of the zooecia, the smaller one, which is inserted more into the middle of the frontal membrane, may perhaps have the additional function of helping to produce the internal pressure which causes the protrusion of the polypide. I have looked in vain for extensor muscles, and I think that the straightening of the branches after flexion is to be explained as an elastic reaction of the inflected zooecia.

The mode of bifurcation (fig. 3; see also Harmer, 1923, Pl. XVI, fig. 6) shows some approach to the condition in *Kinetoskias*. The zooecium A gives rise to two distal successors, C and E, C being composed of all the three sections typically found. The axillary zooecium (E) has no second section, and it possesses no distal joint, no distal tooth and no flexor muscles. It gives rise to F and G, the first inner zooecia of the respective branches. F communicates with E by a pore near the middle of the latter; a similar communication between the corresponding zooecia occurring also in *Kinetoskias*.

The marginal avicularia are situated as in the Scrupocellariidae, and are constantly present on all the zooecia except the axillary zooecia. The base is oval, and in side view the avicularium appears triangular, the short side directed transversely and constituting the biting surface. The distal end of the rostrum is hooked and lies externally, the mandible being transverse (fig. 3). The transverse calcareous bar of the rostrum is complete. The frontal avicularia (fig. 4) were described by Miss Robertson, but in the material examined by me they are larger and stronger than would be inferred from her account. I have found a single avicularium of this type in a certain number of the inflected groups of zooecia at the tips of a branch, but none in other parts. The avicularium, which has a complete calcareous bar, is compressed and broadly funnel-shaped, and is attached by a narrow base to the inner border of the zooecium, in its proximal half. It is remarkably powerful and has strongly calcified walls, but it does not differ substantially from the marginal avicularia except in size. The occlusor muscles occupy most of the head, and even the divaricators are strong. As in the marginal avicularia, the mandible appears to be of the acute type. Although the avicularium is constricted at its base I do not think it is really pedunculate as described by Miss Robertson.

The ovicells (fig. 3), which are very globose and typically hyperstomial, were found by Busk; but Miss Robertson, who found only one, obviously injured ovicell, described them as having an exceptional structure. The fertile zooecia are broader than the others, and they occur in a definite position, no branch developing more than a single ovicell, a fact probably correlated with their large size. This is formed, in the observed cases, from the fourth or sixth zooecium

of the branch, on the inner side as regards the bifurcation; or, in other words, from the second or third inner zooecium. The fertile zooecium contains a polypide (*pol.*) and its operculum is much wider than those of the ordinary zooecia. Its marginal avicularium (*av.*) lies on the basal surface and is not always visible in frontal view. It is sometimes shifted to the middle line, but more usually lies on the outer side of the middle. I have found no testes in the gonozooecia, which are probably definitely female. The ovary (*ov.*) lies near the centre of the basal wall, in some cases containing a large egg. Miss ROBERTSON's figure (D) represents an egg which has partially passed into the ovicell. Other zooecia, in the neighbourhood of a gonozooecium, have a testis (*tes.*), occupying the concavity of the inner lateral wall, and confined to the distal section of the zooecium.

In specimens cleaned with Eau de Javelle, the cavity of the ovicell is widely continuous with the general cavity of the gonozooecium. In uncalcified preparations, the membranous vesicle of a typical Cheilostome ovicell can be distinguished, and it is, as usual, provided with muscles which pass into it from the sides of the gonozooecium. The vertical depth of the ovicell is great, but the terminal wall of the zooecium is low and reduced to a mere strip, just affording room for a transverse row of communication-pores, some of which have a diameter almost equal to the height of the wall and some are much smaller. The gonozooecium has a large *flexor zooecii* (*f. m.*) and the usual joints, but I have not found the smaller flexor of the ordinary zooecia. Typical parietal muscles are present, and these also occur in the ordinary zooecia.

Fam. 3. EPISTOMIIDAE.

Epistomiidae Gregory, 1903, TZS, XIII, p. 223.
Notamiidae Hincks, 1880, BMP, p. 98; et auctt.

Zoarium erect or partially prostrate, jointed and attached by rootlets. Zooecia paired, extending into three internodes, each of which consists of the distal or largest section of a pair of zooecia, the smaller middle sections of two zooecia of the succeeding internode, and the still smaller proximal sections of two zooecia of the next internode but one. Avicularia sessile or pedunculate, borne by the middle sections of the zooecia, the mandibles acute. Gonozooecia formed by the enlargement of certain individuals, ovicells wanting.

The type-genus of this Family is *Epistomia* Fleming, of which the genotype is *Sertularia bursaria* Linn., 1758, SN, p. 814 (see HARMER, 1923, JLS, XXXV, p. 307).

The Epistomiidae are to some extent intermediate between the Scrupocellariidae and the Bicellariellidae, resembling the former in their sessile avicularia, and the latter in their pedunculate avicularia. The constitution of the internodes is peculiar, but the subdivision of the zooecia resembles that found in the Euoplozoidae and in certain Bicellariellidae.

Synnotum Pieper.

Mononota and *Synnota* Pieper, 1881, p. 43.
Synnotum Hincks, 1886, AMNH, 5, XVII, p. 255.
Monotypical. Genotype, *Gemellaria* (?) *avicularis* Pieper, 1881 (syn. of *Loricaria aegyptiaca* Audouin, 1826); see HARMER, op. cit. p. 317).

Internodes separated by joints, which may be evanescent, each composed of four chitinous tubes. Zooecia with the structure indicated under the Family, but much more asymmetrical than in *Epistomia*; without oral or marginal spines. Alternate internodes with corresponding surfaces similarly orientated. One avicularium on the frontal side of each internode, and one or two on the basal side. Most of the avicularia are sessile, but a sessile avicularium on either face of the internode may be replaced by a pedunculate avicularium. The gonozooecia are enlarged zooecia of an ordinary internode, or the proximal members of a double internode.

The Siboga collection includes three species of *Synnotum*, a genus which was introduced by PIEPER, somewhat informally, with the suggestion that it might be known as *Mononota* or *Synnota*. HINCKS (1886) amended one of these names, presumably on etymological grounds, to *Synnotum*, and I think that this name may be accepted. WATERS (1897, JLS, XXVI, p. 14) stated that there is not sufficient reason for separating this genus from *Epistomia* (*Notamia auctt.*), the structure of which was well described by BUSK (1849, TMS, II, p. 110) and HINCKS (1880, BMP, p. 99). In a later paper HINCKS (1886, p. 256) expressed the view that the avicularia of *Epistomia* are sessile, though showing an approach to the pedunculate form. It appears to me that these avicularia, even if not definitely jointed, belong to the pedunculate type, as shown by their resemblance, in form and structure, to the pedunculate avicularia of *Synnotum contortum* (text-fig. 18).

In *Epistomia* the avicularia are paired and are given off nearly symmetrically from two processes of the middle section of a zooecium on the basal side of the internode. The symmetry is not complete, as shown by figs 2 and 3 of Pl. IV of HINCKS' work (1880). The middle section of the zooecium, whether on the frontal or on the basal surface of the internode, lies close to the middle line, but belongs alternately to the right and left sides.

In *Synnotum* the internodes have become more asymmetrical, and the interlocking of the parts of the zooecia composing them more complex. The internode has become a very beautiful mechanical construction, which although agreeing in principle with that of *Epistomia*, is more individualised, partly by the occurrence of joints at each end. The avicularia are, moreover, less uniform (in different species) in their character; and sessile avicularia are usually found, in addition to those of a pedunculate type. The separation of *Synnotum* from *Epistomia* is justified by these differences.

Synnotum pusillum Nordgaard (BMA, Aarb. 1907, N° 2, p. 5, Pl. I, figs 6—10; — 1912, KNVSS, 1911, N° 3, p. 15, text-fig., p. 16) does not appear to belong to this genus; and the author himself had doubts on the subject.

Key to the Siboga species of *Synnotum*.

1	Avicularia sessile and pedunculate; zooecia of a pair at the same level	2.
	Avicularia all pedunculate; zooecia of a pair not at the same level .	3. *S. pembaense.*
2	Avicularia, one on the frontal surface of each internode, two on the basal surface; pedunculate avicularia pear-shaped, with terminal palatal surface	1. *S. contortum.*
	Avicularia, one on the frontal surface and one on the basal surface of each internode; pedunculate avicularia not pear-shaped, with lateral palatal surface	2. *S. aegyptiacum.*

1. *Synnotum contortum* Waters (Pl. XXVII, fig. 1; text-fig. 18).

Synnotum contorta Waters, 1913, BEA, p. 466, Pl. LXIV, figs 16—18. Zanzibar, British E. Africa, 0—10 fath.

3.A. Stat. 7. Batjulmati, Java, coral-reef.
426.A. Stat. 60. Haingsisi, Samau Id, W. Timor, reef.
37.I. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
346.B. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
276.E. Stat. 250. Kur Id, Kei Is, 0—45 M.

Zoarium composed of straggling branches, occasionally bifurcating, the ends circinately curved; attached by rootlets given off by the internodes. Branches with frontal and basal surfaces differentiated, the zooecia paired, with their frontal surfaces directed obliquely away from one another. Orientation of alternate internodes alike, of consecutive internodes unlike and explicable by the assumption that one set of alternate internodes has been rotated through an angle of 90° round the main axis of the branch. Zooecia slightly exceeding two internodes in length, each taking part in the formation of three internodes and traversed by two joints. Every internode is thus constituted by parts of six zooecia, namely the distal, middle and proximal sections, respectively, of three pairs of zooecia which have their frontal membranes in three successive internodes. Avicularia three on the distal half of each internode, one on the frontal surface and two on the basal surface; all sessile, or one of the avicularia pedunculate, its head pear-shaped, its biting surface terminal and its mandible ending in a strong, denticulate spike. Gonozooecia larger than the zooecia, constituting the proximal pair of a double internode.

The complicated structure of the internodes of *S. contortum*, which may be taken as typical of the genus, has required much study. Though apparently biserial, the branch is really 4-serial, each zooecium being in longitudinal series with a zooecium of the next internode but one, as shown by text-fig. 18, A, B, which represent the same zooecia seen respectively from the frontal and basal surfaces. The sharply marked chitinous joint, at each end, consists of four chitinous tubes. In the frontal view (A) the zooecia B, F of the left side and C, G of the right side have their frontal membranes in the general plane of the frontal surface, their lateral neighbours facing outwards. The frontal membrane occupies most of the length of the internode, and is narrow proximally and wider distally, where it is asymmetrical, the outer margin longer than the inner margin. Each zooecium is traversed by a joint, at the proximal end of the internode; and, after having been continued through the entire length of the preceding internode to its proximal end, where another joint occurs, it ends as a short tube in the distal part of a third internode. The zooecium thus consists of a distal section (F^1) and a middle section (F^2), each of the same length as an internode, and a proximal section (F^3), much shorter than the others. The second section of every zooecium which has its frontal membrane in the general frontal plane of the branch passes down its internode on the frontal surface, while the corresponding sections of the zooecia which face outwards are found on the basal side. Seen from the frontal side, C^1 thus appears in frontal view, D^1 in side view, F^2 between these two, and G^3 on the distal side of C^1. The same internode seen from the basal side (text-fig. 18, B) shows C^1 in basal view, D^1 in basal and lateral view, E^2 between them, and H^3 on the distal side of D^1. G^3 and H^3 are in close lateral contact, and the latter can be seen in frontal view

by focussing through F^2. These two segments are shown in each figure only on the surface to which they respectively belong, in order to avoid unnecessary complication of the drawings.

A rootlet is given off from the basal side of each zooecium in which the frontal plane corresponds with that of the branch, and they thus come off alternately on the two sides. Uniporous septula can be seen between F^1 and H^2, and between F^1 and G^2, but I have not found them in other positions. As in *Bugula*, no definite operculum is differentiated.

Three avicularia (text-fig. 18) constantly occur in each internode, except in those immediately succeeding a bifurcation, where one of the basal avicularia is suppressed. The great majority are sessile, forming mound-like swellings, longer than wide, and narrower proximally than distally. The rostrum has a slightly hooked end; and the mandible, which is hinged distally, is acute and curved towards it. At the extreme proximal end the avicularium has a pore in its wall. On the frontal surface (A) the avicularia slope alternately in different directions, in successive internodes, in each case towards the opesia seen in side view. On the basal surface (B) the avicularia are situated on the two sides of the second zooecial section in the middle of the internode. In a few cases one of the basal avicularia has an entirely different character, being carried on a delicate, flexible stalk (B), and then suddenly dilating into a strongly calcified head, of a pear-like shape. The terminal surface has a strongly hooked rostrum, and the terminal spike of the mandible is a triangular lamina, denticulate on its distal edge, as shown by WATERS (Pl. LXIV, fig. 18).

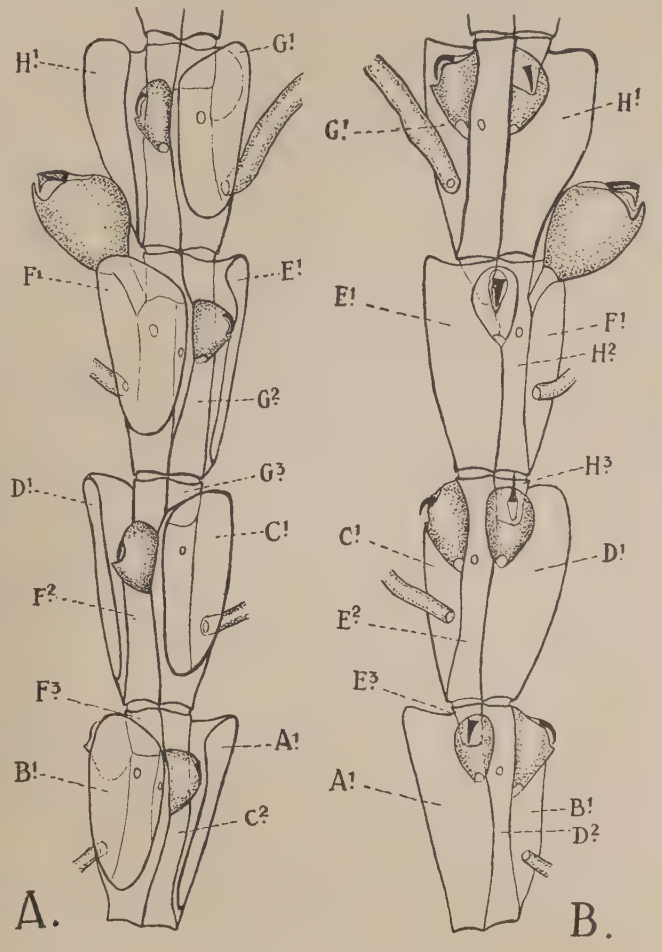

Fig. 18. — *Synnotum contortum.*
A, Branch (31. A^1) in frontal view; B, the same branch in basal view. F^1, F^2, F^3, the three sections of the zooecium F; and similarly with other zooecia. For explanation, see text. Obj. C, reduced $^2/_3$.

An occasional internode contains the distal sections of two pairs of zooecia (Pl. XXVII, fig. 1), of which the proximal pair is considerably enlarged. These are shown to be gonozooecia by the presence, in one of them, of a stained egg or embryo. One of the gonozooecia overlies and conceals the other in the figure. The joint which should normally occur at the middle of this double internode has been suppressed, but the two distal zooecia retain their normal position, as shown by the fact that their orientation is the same as that of the zooecia of the preceding internode. Each gonozooecium is terminated distally by a small, tubular structure, probably a vestigial avicularium of the distal half of the internode. Counting these as avicularia, the double

internode has five of these structures, and it appears that one of the basal avicularia of the proximal series of three is wanting.

2. *Synnotum aegyptiacum* (Aud.). (Pl. XXVII, figs 3, 4).

Gémellaires, Savigny, DE, Pl. XIII, figs 4^1—4^5 (see HARMER, 1923, JLS, XXXV, p. 310).
Loricaria aegyptiaca Audouin, 1826, EPS, p. 243; 1828, p. 75.
Gemellaria egyptiaca D'Orbigny, 1851, PFTC, p. 46.
Gemellaria (?) *avicularis* Pieper, 1881, pp. 43, 47, Pl. II, figs 5—7. Adriatic.
Synnotum aviculare Hincks 1886, AMNH, 5, XVII, p. 257. Adriatic.
Synnotum aviculare Kirkpatrick, 1890, JLS, XX, p. 504. Fernando Noronha, off Brazil.
Synnotum aviculare Waters, 1897, JLS, XXVI, p. 14, Pl. I, figs 6, 7. Naples, Rapallo, S. Africa, etc.
Synnotum aviculare Waters, 1909, SRS, p. 129. Many localities, including Mediterranean, Victoria, Sudanese Red Sea.
Synnotum aviculare Calvet, 1902, TIZM (2), 12, p. 5. Corsica.
Synnotum aviculare Robertson, 1905, NCNA, p. 286, Pl. XIV, figs 84, 85. California; — 1921, BBB, p. 35. Madras, Palk Strait.
Synnotum aviculare Thornely, 1907, MPIM, p. 183. Andamans and other localities in the Indian Ocean; — 1912, PIOS, p. 139. Amirante Is.
Synnotum aviculare Osburn, 1914, CIW, 182, p. 191. Tortugas Is, Florida.
Notamia gracilis MacGillivray (fide Waters, 1897), 1890, PRSV (n. s.), II, p. 106. Port Jackson.
Gemellaria macrostoma Ortmann, 1889, ANG, LVI, 1, p. 23, Pl. I, fig. 15, Japan, 70 fath.

281. C. Stat. 43. Pulu Sarassa, Postillon Is, 0—36 M.
16. B. Stat. 49a. Sumbawa, E., 69 M.
20. B. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
269. E. Stat. 60. Haingsisi, Samau Id., W. Timor, 0—36 M.
339. C. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
459. C. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
62. J. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.
118. C. Stat. 164. W. of N. end of New Guinea, 32 M.
662. A. Stat. 172. Gisser, E. Ceram, 18 M.
346. D. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
276. C. Stat. 250. Kur Id, Kei Is, 20—45 M.
305. B. Stat. 273. Jedan, Aru Is, 13 M.
209. C. Stat. 285. Timor, E., S. coast, 34 M.
255. C. Stat. 311. Sapeh, E. Sumbawa, 0—36 M.
416. F. Stat. 321. Java Sea, 82 M.

Cambridge, Mus. Zool.: —

Singapore, New Harbour, 6 fath., R. HANITSCH, Reg. Apr. 10, 1900.
BM Japan, 6. E, 7. T, Off Tokyo, 30—50 fath., A. OWSTON, Reg. June 23, 1902.

Zoarium erect, or with its older branches prostrate and attached by rootlets, sometimes borne on a stalk covered by longitudinal, sinuous rootlets; reaching a length of 30 mm. Branches not circinate, most of the internodes not producing rootlets. Basal and frontal surfaces differentiated, the zooecia paired, both members of a pair facing obliquely laterally, the alternation in the orientation of the internodes less marked than in *S. contortum*. Construction of the internodes and joints as in that species. Avicularia two on each internode, one on the frontal and one on the basal surface, mostly sessile, but the frontal avicularium sometimes pedunculate, not definitely pear-shaped, with the palatal surface lateral. Gonozooecia produced by normal, not by double internodes.

In the absence of descriptions in some cases, it cannot be considered certain that all the references given in the synonymy belong to the present species. WATERS (1897, p. 15) recognised that *S. aviculare* is identical with AUDOUIN's species, and this conclusion seems to me established by the following facts. The general habit and mode of bifurcation, as represented by SAVIGNY, the restriction of the rootlets to a few internodes, and above all the participation of the middle sections of two zooecia in the formation of the internode (see his frontal and basal views, figs 4^3 and 4^5), all closely correspond with *S. aviculare* Pieper. The small opesia shown by SAVIGNY can be found in *S. aegyptiacum*, as here understood, in the more proximal zooecia, where secondary calcification has reduced the original size (see p. 400). SAVIGNY appears not to have noticed any of the zooecia in their typical, unaltered condition.

It will be seen from the synonymy that *S. aegyptiacum* is almost world-wide in its distribution, having been recorded from the Mediterranean, the Red Sea, the Western side of the Atlantic (Fernando Noronha, Tortugas Is), S. Africa, the Pacific (California, Japan), various localities in the Indian Ocean, Port Jackson and Victoria. It is a very delicate and inconspicuous species, and it doubtless remains to be discovered in many other localities.

Calwellia gracilis Maplestone, a Victorian species, must be referred to here, in consequence of the fact that different authors appear to have included two distinct species under this designation. The name was first mentioned in a notice of a paper read by MAPLESTONE (1882, QJMSV, I, N° 4, p. 108), but without description. It was figured by this author in the same year (1882, PRSV, XVIII, Plate, fig. 9), but was not mentioned in the text (p. 48). The species thus illustrated shows ovicells, but no avicularia, and it was correctly referred to *Calwellia* Wyville Thomson (1858, NHR, V, p. 146), which is not synonymous with *Synnotum*. In 1886 MACGILLIVRAY (PRSV, XXII, p. 128) gave a short description of Victorian specimens with paired avicularia, referred by him to *Calwellia gracilis* Mapl., but in 1890 (PRSV, n. s., II, p. 106) he expressed the doubt whether his former determination had been correct. WATERS (1897, p. 15) has stated that a Victorian specimen sent to him as *C. gracilis* MacGill. proved to be *Synnotum aviculare* (*aegyptiacum*), which thus seems to extend to the S. coast of Australia.

S. aegyptiacum differs from *S. contortum* in many respects. The habit and the zooecia are much more delicate, and most of the internodes do not produce rootlets. There is only one basal avicularium on each internode (instead of two), and the occasional frontal pedunculate avicularia differ markedly from those of the other species. The gonozooecia are, moreover, produced on normal internodes.

The zooecia of *S. aegyptiacum* are constructed essentially like those of *S. contortum*; each internode being formed of parts of six zooecia. There is not much alternate rotation of the internodes round the main axis, though in a frontal view one internode shows more of the right opesia and the next more of that of the left side. The frontal membranes of both zooecia are in fact more symmetrically arranged than in *S. contortum*. The sessile avicularia resemble those of the other species, but the pedunculate avicularia are very different, the head being more similar to that in *Bugula*, and having a lateral biting surface, a strongly hooked rostrum and a deeply excavated palatal surface; in the last respect resembling *S. contortum*. A gonozooecium (fig. 4), distinguished by its greater width, is frequently developed as one member of a normal internode; and the avicularium on its distal side is not vestigial. At the bifurcation, there is

only one complete zooecium in the basal internode of each branch, and the zooecium of the second internode which should have its middle section running along the entire length of the first internode, on its basal side, reaches no further than the distal part of the first internode (fig. 3, *x*).

The specimen 6. E, from Japan, shows a modification of its proximal internodes which is so considerable that it could hardly be recognised as belonging to this species if it were not for the presence of a younger branch in which the zooecia and avicularia are normal. The species in this modified form has been described by ORTMANN (1889), from Japan, as *Gemellaria macrostoma*. In the older internodes of 6. E the frontal membrane has completely calcified, continuing the convexity of the basal surface. The zooecia now appear symmetrical and paired, both equally convex and pyriform. The walls are thickened, and the second sections of the zooecia are seen with difficulty. Remains of sessile avicularia are distinguishable on some of these modified internodes, which give off rootlets, ending in complicated attaching lobes. Rootlets are also produced on the succeeding internodes, each from a thick, ring-like communication-plate, formed alternately on either side of the main longitudinal septum between the two principal zooecia. It seems to me practically certain that SAVIGNY's figures were taken from zooecia in this condition.

The Siboga specimens 339. C show similar features, in proximal parts of the colonies which were prostrate. Rootlets are given off from communication-plates, as in the Japanese specimen, two of which may occur on the same zooecium, on its basal surface, close to the main septal line. The rootlets expand at their ends into branched attaching laminae, and the contents of the modified zooecia are yolk-like, as is the case in the Japanese specimen. Instead of a rootlet, one of these plates may give off a new jointed stem, commencing with a single cylindrical joint, hardly longer than wide, followed by a longer cylindrical kenozooecium of small diameter. The next segment consists of a short zooecium, with a basal, sessile avicularium and a recognisable opesia, as well as the narrow proximal end of a zooecium of the succeeding internode, which is normal.

The gonozooecia (339. C) are less conspicuous than in *S. contortum*, and only one of the two zooecia of an internode is thus modified (fig. 4). In its later state the polypide has disappeared, and there is a solid stained body, presumably a small embryo, near the basal surface. The fertile zooecia may be recognised by the possession of a strong, asymmetrical muscle, originating from the external and basal walls and passing obliquely to the middle of the distal end of the gonozooecium. This doubtless corresponds with one of the muscles inserted into the membranous vesicle in other Cheilostomes. I have not found it, however, in the enlarged zooecium shown in fig. 4.

3. *Synnotum pembaense* Waters (Pl. XXVII, fig. 2).

Synnotum pembaensis Waters, 1913, BEA, p. 465, Pl. LXIV, figs 12—15. British E. Africa, Zanzibar, 2—10 fath.

487. D. Stat. 129. Karkaralong Group, S. of Mindanao, 23—31 M.

British Museum: —

China Sea, Tizard Bank, 35 fath., 89. 8. 21. 129—135 (two slides).

Zoarium delicate, the joints obscure and the internodes less distinctly marked than in the other species. Internodes rotated alternately round the axis of the branch, the zooecia of a pair

not at the same level. Avicularia two on each internode, all pedunculate, situated at the outer distal end of the zooecium, but arising from the middle section of a zooecium of the succeeding internode. Opesia and palatal surface occupying the entire flattened side of the avicularium, of about equal length, separated by a complete calcareous bar; the opposite side strongly arched, and the end of the rostrum hooked. Opesia of zooecium occupying almost the entire frontal surface of the internode; the second section, in the next preceding internode, giving off a tubular process along the basal surface of one of the zooecia of this internode, connected with the stalk of the avicularium borne by that zooecium. Gonozooecia not found.

The construction of the internodes is essentially as in the other species, but the joints are indistinct, although visible as chitinous tubes, in suitably stained specimens. The individuality of the internodes is further masked by the fact that, in each pair of zooecia, one projects further distally than the other. The alternate orientation of the internodes is even more marked than in *S. contortum*, and the zooecia of a pair are almost back to back. The opesia is wider distally than proximally. The avicularia differ from those of the other two species in being all pedunculate. Although varying considerably in size, they all have the same general form. The tentacles are 9 or 10, and rootlets are as a rule not developed from the distal internodes.

In the original description WATERS describes the avicularia as being all of the pedunculate type, and my own figure shows a substantial agreement with his, one of which appears to indicate that the zooecia of a pair are not at the same level. The number of tentacles is given by him as 10. The specimens from the Tizard Bank in the British Museum consist of short erect stems, arising from a delicate, branching stolon, as in WATERS' description.

Fam. 4. FARCIMINARIIDAE.

Zoarium erect, not much calcified, with narrow branches and few bifurcations, Cellariiform, or flattened and then unilaminar or bilaminar; usually anchored by a basal tuft of rootlets. Zooecia elongate, the aperture occupying the entire front or nearly so, with or without spines. Avicularia present (adventitious) or absent, not jointed at the base. Ovicells large and entozooecial, or reduced, or completely absent.

The species are usually characteristic of abyssal depths. As explained above (p. 191) I regard the entozooecial ovicells, in this Family, as representing hyperstomial ovicells arrested in their development.

Farciminaria was established by BUSK (1852, BMC, p. 32) for a single species, *F. aculeata*. Eight new species, from the Challenger Collection, were described by the same author in 1884; and to these WATERS (1888, Chall., p. 38) added another, *F. biseriata*, from the same Collection. The Challenger slides in question, in the British Museum, are unfortunately not altogether satisfactory, but I think that *F. biseriata* may be definitely excluded from the genus. *F. punctata* Kirchenpauer (1869, Mus. Godeffr., Cat. IV, p. XXVII), from S. Africa, which the author thought might be the form figured by BUSK (1852, BMC, Pl. LXV*bis*, fig. 7), as *F. flexilis*, but not described, appears to have no claim to be placed in the Anasca. The species may be arranged in four groups, probably entitled to generic rank.

1. Farciminaria Busk.

Farciminaria Busk, 1852, BMC, p. 32.
Farciminaria (pars) Busk, 1884, Chall., p. 48.
Farciminaria Levinsen, 1909, MSSB, p. 117.
Monotypical. Genotype, *F. aculeata* Busk, 1852, p. 33.

Branches cylindrical, the zooecia in six series (except in *F. uncinata*, which is 4-serial), opening all round the branch, which may at first be 4-serial but at once becomes 6-serial by the doubling of two rows at its proximal end. Spines present or absent. Avicularia unknown. Ovicells large and prominent, entozooecial.

Farciminaria, which does not appear to be abyssal, is not represented in the Siboga Collection. The following species should probably be left in it: —

Farciminaria aculeata Busk, 1852, BMC, p. 33. Tasmania, New Zealand.
Farciminaria simplex MacGillivray, 1886, PRSV, XXII, p. 130; — 1888, PZV, XVI, p. 218. Victoria, 10—15 faths (nec *F. simplex* Kluge, 1914, BDSE, p. 650).
Farciminaria uncinata Hincks, 1884, AMNH, 5, XIV, p. 277. Victoria (see also Levinsen, 1909, MSSB, p. 117).

2. Levinsenella n. gen.

Farciminaria (pars) Busk, 1884, Chall., p. 48.
Columnaria (pars), Levinsen, 1909, MSSB, p. 116.
Genotype, here selected, *Farciminaria brasiliensis* Busk, 1884, p. 50.

Branches square in transverse section, the zooecia long, in 4 longitudinal rows, one of which belongs to each of the four faces of the branch. Bifurcation as in text-fig. 20, A. Spines wanting. An avicularium typically present at the proximal end of the zooecium (not found in *L. delicatissima* and *L. carinata*). Ovicells large and prominent, as in *Farciminaria*.

Distribution of the known species, deep water in the Atlantic and Antarctic (the form referred by Kluge, 1914, BDSE, p. 650, to *F. magna* Busk), E. of Japan and S. W. of Australia. The species, as below, which I include in *Levinsenella* were all placed by Levinsen (p. 117) in his genus *Columnaria*, a name invalidated by *Columnaria* Goldf., 1826 (see Harmer, 1923, JLS, XXXV, p. 305). Levinsen selected no genotype.

Farciminaria brasiliensis Busk, 1884, Chall., p. 50. E. of Brazil, 32—400 fath.
Farciminaria cribraria Busk, 1884, p. 49. E. of Buenos Aires, 1900 fath.
Farciminaria magna Busk (incl. var. *armata* Busk), 1884, pp. 49, 50. E. of Buenos Aires, 1900—2650 fath.; S. W. of Australia, 1675 fath.
Farciminaria pacifica Busk, 1884, p. 50. E. of Japan, 2300 fath.
Farciminaria gracilis Busk, 1884, p. 51. E. of Brazil, 32—400 fath.; W. of Azores, 1675 fath.
Farciminaria delicatissima Busk, 1884, p. 51. Atlantic, various localities, 1850—2400 fath.
Columnaria borealis Levinsen, 1909, MSSB, p. 116, N. Atlantic, 1715 fath.

Busk's var. *armata* of *L. magna*, distinguished by the possession of avicularia, seems to be unnecessary, as an avicularium occurs on each of two specimens (87. 12. 9. 227, 228) from Stat. 325, referred by Busk himself to the typical form of the species.

1. *Levinsenella carinata* [1]) n. sp. (Pl. XVIII, figs 1, 2, 3, 5; text-figs 19, 20 A).

Type. 155.A. Stat. 211. S. of Celebes, 1158 M.
527.A. Stat. 212. S. of Celebes, 462 M.
529.A. Stat. 221. Banda Sea, 2798—3112 M.
160.A. Stat. 227. Banda Sea, S. of W. end of Ceram, 2081 M.

Zoarium reaching a length of 60—110 mm., very slightly calcified, attached by a tuft of rootlets to the ooze, branching in one plane, commencing with a stalk, expanded just before the first bifurcation; the branches arranged as in a candelabrum. Zooecia long, in alternate pairs, the two members of a pair opposite one another, meeting back to back in a spindle-shaped area of approximately half their length. Lateral septula 2 in the distal half, nearer the frontal than the basal surface. Lateral edges of zooecia nearly parallel. Gymnocyst, cryptocyst, avicularia and spines wanting. Orifice close to the distal end, appearing bilabiate, owing to the projection of the distal wall of the zooecium and of the slightly open operculum, which is Membraniporine, without basal sclerite. Ovicells extremely large and conspicuous, variable in length, sometimes almost as long as the kenozooecium succeeding them; longer than wide, the greatest width in the distal half. Entooecium more highly calcified than any other part of the colony, entirely covered, except on its strong, imperforate, median keel, by closely apposed, deep, funnel-shaped pits, each ending in a pore. Proximal edge of entooecium strongly raised, so as to limit a deep channel running round the frontal surface to the median keel. At the bifurcation (text-fig. 20 A), A and B each produce two distal successors, but the axillary zooecium (E) develops no orifice nor operculum. Rootlets given off at the proximal ends of zooecia at the base of the colony.

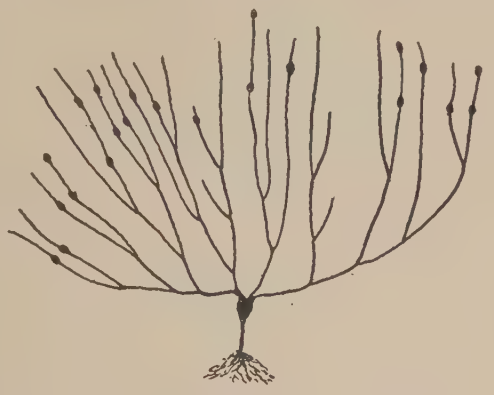

Fig. 19. — *Levinsenella carinata*. Zoarium (155. A) bearing ovicells. Natural size.

The stalk of the colony (text-fig. 19) is about 10 mm. long, and at its upper end it passes into a small expansion, flattened in the plane of the branches and formed by a central axis of zooecia, bordered by numerous rootlets, which are apposed to form a cylindrical stem before they diverge into the basal tuft.

In 529. A (fig. 2), some of the ovicells are specially long, and the frontal edges of the septa between the zooecia are conspicuously outlined by accumulations of deep brown granules, which lie in or immediately beneath the ectocyst. A prolongation of this brown line extends along the keel of the ovicell, and gives off pinnately arranged branches. Brown lines of this kind have often been described in Cheilostomes, and I think they may be due to the formation of excretory granules of the kind previously described by me (1891, QJMS, XXXIII, p. 159).

The spindle-shaped apposition of the basal surfaces of the two zooecia of a pair is shown in fig. 1. The spindles visible belong to the pairs of which one member is seen in frontal view. Their limitation by the divergence of the proximal and distal ends of the alternate zooecia is represented, and it will be obvious that the spindles of these alternate pairs lie vertically in the

1) Referring to the conspicuous keel on the ovicell.

figure, which merely shows their edges. Several of the zooecia in 155. A are traversed by sponge-spicules, both ends of which may project to the exterior. This probably means that the

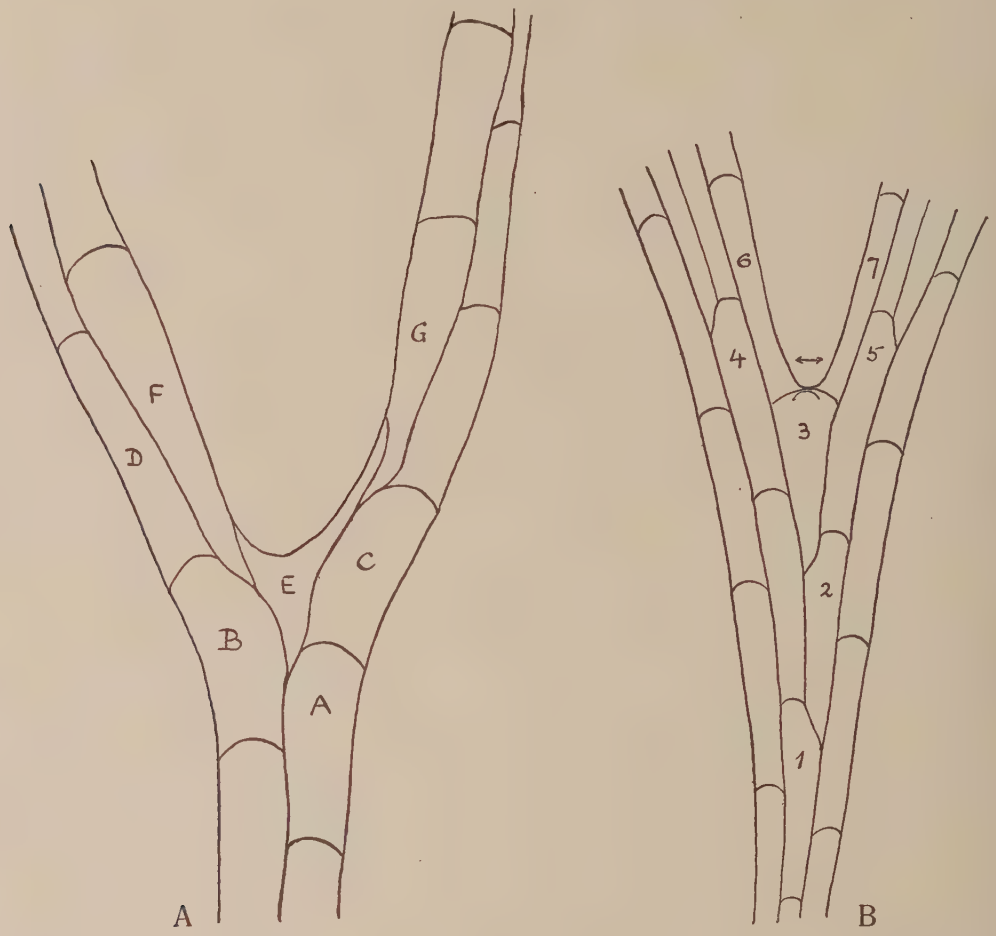

Fig. 20. — Bifurcations. A, *Levinsenella carinata* (155. A²); B, *Farciminellum hexagonum* (210. A¹) (p. 405). For explanation, see text. Greenough a², reduced ³/₄.

soft substance of the growing edge encountered a spicule, extending round it and including it in the body-cavity. In another case a spicule lies completely in the body-cavity. A single, very large egg, at first attached to the basal wall, is produced by a fertile zooecium.

3. **Farciminellum** n. gen.

Farciminaria (pars) Busk, 1884, Chall., p. 48.
Genotype, *Farciminaria hexagona* Busk, 1884, Chall., p. 51.

Branches pluriserial, bilaminar, flattened, with at least 3 series of zooecia on each face, those of the basal surface being kenozooecia, without orifice or operculum, with the exception of the marginal row on each side. Median and lateral zooecia differentiated, as in *Himantozoum* (Bicellariellidae), their proximal ends not conspicuously forked, and hardly overlapping their predecessors. Spines and avicularia present or absent, the mandibles rounded. Ovicells present

(*F. alice*) or large eggs in the zooecial cavity, correlated with the absence of ovicells, as in *Himantozoum*. Bifurcation as in text-fig. 20, B.

I refer the following species, in addition to the genotype, to this genus: —

Farciminaria atlantica Busk, 1884, Chall., p. 49. W. Indies, 390—450 fath.
Farciminaria alice Jullien and Calvet, 1903, BCH, pp. 36, 124. Azores, 1300—1557 M.
Flustra linearis Kluge, 1914, BDSE, p. 657. Antarctic, 2910 M.
(?) *Farciminaria simplex* Kluge, 1914, p. 650, Antarctic, 380 M. (nec *F. simplex* MacGillivray, 1886, PRSV, XXII, p. 130. Victoria).

Farciminellum is a deep water genus, specially characterised by its bilaminar fronds, one layer consisting of kenozooecia. Busk mentioned this feature, without distinguishing the surfaces, in *F. hexagonum* and it can be observed in his preparations of *F. atlanticum*. The kenozooecia of *F. hexagonum* are described below. Those of *F. atlanticum* have spines, agreeing in number and size with those of the opposite surface, and avicularia are developed on both surfaces. Kluge specially noticed the layer of kenozooecia in *F. lineare*, which further agrees with *F. hexagonum* in having two kinds of zooecia, in the character of the avicularia and in the absence (so far as is known) of ovicells.

The modifications of the ovicells in *Farciminellum* are of special interest. *F. alice* resembles *F. atlanticum* so closely in its general characters (although a basal layer of kenozooecia has not been noticed) that it can hardly be placed in a different genus. It has well developed ovicells, structures which are smaller in *F. atlanticum* and absent in *F. hexagonum*. These facts appear to point to a derivation from forms with well developed ovicells, which are in course of reduction within the genus, as has probably occurred in other lines of Cheilostome evolution.

1. *Farciminellum hexagonum* (Busk). (Pl. XVIII, figs 8—10; text-fig. 20, B).

Farciminaria hexagona Busk, 1884, Chall., p. 51, Pl. XIV, fig. 10; Pl. XXXI, figs 3—3*b*. Marion Id, 140—310 fath.; E. of Celebes, and Amboina, 825—1425 fath.
Farciminaria hexagona Harmer, 1902, QJMS, XLVI, pp. 265, 289.
Farciminaria andamanensis Robertson, 1921, BBB, p. 44, text-fig. 4. Andaman Is.

517.A. Stat. 175. N. of E. end of Ceram, 1914 M.
151.A. Stat. 210a. Gulf of Boni, S. of Celebes, 1944 M.
158. B. Stat. 221. Banda Sea, 2798—3112 M.
200.A. Stat. 280. E. of Timor, 1224 M.
210.A. Stat. 295. S. of W. Timor, 2050 M.

Zoarium only slightly calcified, reaching a length of at least 100 mm.; rootlets very delicate. Stalk bifurcating rarely, at an acute angle. Branches with as many as 12—13 longitudinal rows of zooecia, on each surface, towards their distal ends, the colony here assuming almost the form of a narrow, bilaminate *Flustra*. On the frontal surface all the zooecia are provided with an operculum and orifice, and are very long, parallel-sided, without spines, the orifice terminal, the cryptocyst undeveloped. On the basal surface, the two marginal rows alone possess fully developed zooecia, the remainder having the form and size of zooecia, but without operculum or orifice, the opesia sometimes greatly reduced by an extensive cryptocyst. Avicularia restricted to the basal surface, occurring at the junction of the distal wall of a marginal zooecium with

a kenozooecium; conical, with a nearly semicircular mandible (Fig. 9). Ovicells wanting, the fertile zooecium producing an extremely large egg. At the bifurcation (text-fig. 20, B), the formation of an axillary zooecium is preceded by the doubling of a row or rows of zooecia, in such a way as to provide the median rows of the branches.

210. A^1 has a total length of 41 mm., and has 4 bifurcations, all forming acute angles. The common stem is 13 mm. long; the distance from the first to the second bifurcation being 6 mm. in the right branch and rather less in the left. One of the branches of the right half has another bifurcation after 8 mm., while the left branch has a length of 20 mm. and is undivided. At its base the main stem gives off a profusion of thin rootlets, which are so delicate that their walls collapsed in Canada balsam. At its origin the stem has a calcareous axis, which appears to be constituted by the more central parts of the walls of zooecia which are not individually recognisable. The axis dilates at regular intervals, a process accompanied by the formation of 6 longitudinal ridges on it; and the ridges have each a transverse chitinous line at the middle, together constituting a joint. When the zooecia become distinct the stem is quadriserial, the four series each constituting one side of a stalk which is nearly square in section. The zooecia are now in alternating pairs, the basal walls of each pair completely in contact. At the distal end of the 11^{th} pair a doubling of the number occurs on each surface, forming a middle row, which consists of kenozooecia on the basal surface of the branch. The second zooecium of this median row produces two distal successors, on each surface. It is shown in text-fig. 20, B and is marked 1, the drawing being from the frontal side. Successive doublings take place at the same level on both surfaces. A new doubling occurs at the distal end of 2; the inner member of the pair being axillary. Before its formation, a median row had been provided for each of the branches, by the doubling which took place at the distal end of 1. The process is exactly similar on the basal surface, but all the zooecia, including the axillary zooecium, with the exception of the two marginal rows, remain as kenozooecia. Avicularia begin to appear, on the basal surface only, at the distal end of the second pair of recognisable zooecia, but at first alternately on successive zooecia. The avicularia are paired after the second bifurcation, and then have the position shown in fig. 8.

In other specimens the number of rows is larger. Thus in 200. A it rises to 12—13 immediately before the bifurcation, by an extension of the process which is indicated in text-fig. 20, B. Even in this condition all the zooecia of the basal surface are kenozooecia, except those of the two marginal rows.

Text-fig. 20, B (p. 404) represents the first bifurcation of a colony. In the same specimen the next bifurcation, in each of the first two branches, takes place in such a way that the zooecium 3 does not reach the axil, from which it is separated by the union of the proximal ends of 6 and 7, the cavities of which appear to be continuous, though each has its own normal orifice. The second bifurcation of one of the branches shows a further variation, as the axillary zooecium forms no terminal wall in the usual place, but extends on each side, without interruption of its cavity, as far as the double arrow in the figure, where a normal orifice is developed on each side. This zooecium has, accordingly, the form of a Y with short arms, each of which ends in an orifice, no median orifice being present. These irregularities may be regarded as variations of a structure which is perhaps becoming a kenozooecium. It may be noted that no polypides

are present in 3, though they may have occurred at an earlier stage of growth. On the basal surface, three of the four bifurcations have a Y-shaped axillary zooecium.

210. A shows an enormous, elongated egg (fig. 10) in several of the zooecia of the central rows.

4. Didymozoum Harm.

Didymia Busk, 1852, VR, p. 383; — 1852, BMC, p. 35.
Didymia Levinsen, 1909, MSSB, pp. 88, 98.
Didymozoum Harmer, 1923, JLS, XXXV, pp. 306, 307.

Didymozoum was proposed by me to replace *Didymia* Busk (pre-occupied by *Didymia* Le Peletier and Serville, 1828 [1]), and with the same genotype, *Didymia simplex* Busk, 1852, VR, p. 384. Busk defined this genus (1852, BMC, p. 35) as having paired zooecia, all facing the same way, an opesia occupying practically the whole front and bifurcating in such a way that each participating zooecium gives off a secondary pair at its summit. Waters (1887, AMNH, 5, XX, p. 90) has stated that a zooecium is occasionally budded off from the front of a pair, and that the branch so formed consists at first of a single zooecium. Levinsen, who placed this genus in the Bicellariellidae, stated that there are no lateral rosette-plates, but Waters (op. cit., p. 91, Pl. IV, fig. 20) has described a proximal and a distal lateral communication-pore in *D. simplex*. Avicularia are unknown.

In zooecial characters and more particularly in the entozooecial ovicells *Didymozoum* closely resembles certain Farciminariidae, in which Family I think it should be placed.

1. *Didymozoum triseriale* (Phil.). (Pl. XIX, fig. 1).

Didymia triserialis Philipps, 1899, WZR, pp. 440, 442, Pl. XLII, figs 2, 2*a*. New Caledonia [2]).

440. A.) Stat. 37. Sailus Ketjil, Paternoster Is, 0—27 M.
649. A.)
57. O. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
467. D. Stat. 91. Muaras Reef, E. Borneo, 0—54 M.
139. E. Stat. 164. W. of N. end of New Guinea, 32 M.
353. C. Stat. 240. Banda, Banda Sea, 9—45 M.

Zoarium erect, unilaminar, the stems arising from a creeping stolon consisting of elongated kenozooecia. Zooecia paired, all facing in one direction, but slightly oblique, their frontal planes sloping down from the median line of the branch; relatively longer and narrower than in *D. simplex*; a joint across the proximal end of each pair. Calcareous matter very slightly developed. Bifurcation as in *D. simplex* (Harmer, op. cit., p. 325, Pl. XVI, fig. 1). Ovicell entozooecial, intercalated between two ordinary zooecia, not necessarily at a bifurcation and not covered by a kenozooecium.

The ovicells constitute the most striking difference between this species and *D. simplex*, as was pointed out by Miss Philipps, whose account I can confirm. In 467. D and 649. A, several stems arise from a creeping stolon, formed of a row of cylindrical kenozooecia, longer than the zooecia, attached by membranous rootlets and with a vestige of an opesia distally.

1) C. D. Sherborn, 1922, IA, p. 1911.
2) Type specimen in the British Museum.

Just proximally to the opesia arise erect stems, usually one from a kenozooecium, but sometimes two with their bases in contact. These are generally composed at their bases of a single zooecium, which gives rise to two distal successors. The stem remains for the most part biserial, bifurcating in this condition, until the branches become fertile, when a triserial condition is acquired, the middle member bearing an ovicell.

The zooecia are very delicate, with little calcification, and their frontal planes have a considerable slope, towards the basal surface, from the middle line of the stem. The opesia occupies nearly the whole surface, but a short gymnocyst may occur at the proximal end, which is traversed by a joint passing across the basal surface. The orifice is terminal, the operculum without basal sclerite. The terminal wall is not so much sloped as in *D. simplex*, in which the orifice is not quite terminal. The polypide possesses a typical pharynx, in opposition to the statement of Busk (1884, Chall., p. 47) for *D. simplex*. The tentacles are about 22, and there are two retractor muscles, as in that species.

The proximal end of the zooecium is slightly equitant, basally, on its predecessor, forming a transverse concave line, extending across the whole width of the distal end of the proximal zooecium. At the bifurcation of a biserial branch (see above and Philipps, 1899, Pl. XLII, fig. 2*a*) the proximal ends of the inner zooecia of the branches are rather more forked than elsewhere. The triserial condition is inaugurated by the doubling of the number of zooecia in the inner row of a branch; and at the next bifurcation the two rows thus produced pass directly into the branch of that side, the doubling of the outer row occurring in the usual way at the distal end of the internode. The fertile zooecium thus remains in series with the inner row of the branch of its own side.

Ovicells (fig. 1) are present in 57. O and 649. A, and two or even three may occur in succession in a triserial branch, while in other cases there is a single ovicell, immediately preceding a bifurcation, as in *D. simplex*. They are relatively longer than in that species, in which the ovicell was described by Levinsen (1909, p. 98) as being covered by a kenozooecium. In *D. triseriale* it is the proximal end of the next zooecium which covers the ovicell, even in the case of an axillary ovicell, as explained above. The ovicells are entozooecial, the entooecium being well calcified, and the ectooecium being represented merely by part of the frontal membrane of the next zooecium. They appear to have substantially the same structure as in the diagrammatic figure 1, A on p. 202, but the fold indicated by *Ent.* and *Ect.* is reflected proximally as far as the orifice, thus increasing the length of the entooecium. I have not demonstrated the presence of the membranous vesicle (*M. V*). The fertile zooecia are wider than the others, and their orifice is also wider. An ovary occurs, in the middle line, near the distal end of the fertile zooecium, on its basal wall. Male cells are here absent, but some of the other zooecia have elongated masses of sperm-morulae, near the basal part of the proximal wall.

2. *Didymozoum marginatum* n. sp. (Pl. XIX, fig. 2).

Type. 38. P. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
555. H. Stat. 320. Java Sea, 82 M.

Erect, unilaminar, the lower part of the stem giving off a tangle of rootlets. Branches mainly uniserial, but becoming biserial before a bifurcation. Zooecia opening on one surface of

the branch, their frontal membranes in the same plane; elongate, jointed proximally, the lateral walls of the zooecia strongly calcified, the frontal surface almost entirely occupied by the opesia, which is reduced by a narrow cryptocyst. Orifice terminal, the operculum Membraniporine. Zooecia bordered, on each side, by a membranous tube, subdivided at intervals by small calcareous projections given off from the middle of the zooecia. Ovicells not found.

The two colonies are about 25 mm. long, and commence with a stalk which is uniserial, a condition retained at the bases of all the branches. Sooner or later the number is doubled, the branch either bifurcating immediately, or remaining biserial for as many as four pairs of zooecia. The basal wall is nearly flat, thin and very little calcified. The lateral walls are thick, strongly calcified bars, pierced by four to five communication-pores, situated near the basal wall, and present on the outer walls as well as on the wall separating two zooecia. The opesia at first occupies the entire front, but becomes restricted in the young zooecia by a lobe of cryptocyst developed from the proximal end of each lateral wall (uppermost zooecia in fig. 2), and soon uniting in a median suture. As growth proceeds, the cryptocyst extends along the lateral walls as a narrow lamina, which in the old condition may be prolonged round the distal margin. A joint passes across the proximal end of each zooecium, in the region where the cryptocyst has been completed across the middle line, and the joint here becomes complicated by the development of a calcareous flange on each side. At the bifurcation these flanges form a pair of elongated calcareous bars, uniting at an angle of about 100° in the axil.

The most peculiar feature of the species is the occurrence of a membranous tube which borders the entire branch, on each side (hence the trivial name). While this tube is frequently continuous for a length of several zooecia, it is often subdivided by a small calcareous bracket, given off from the middle of the zooecium. The rootlets near the commencement of the colony originate from this tube and are themselves uncalcified. The communication-pores between the zooecia and the marginal tubes suggest the view that the tubes are to be regarded as rows of kenozooecia, perhaps indicating an origin from an ancestor with a pluriserial branch.

None of the zooecia have functional polypides, and the cavities of the proximal ones are crammed with a yolk-like material, which might perhaps have been used for the regeneration of branches with complete zooecia containing polypides.

Fam. 5. Bicellariellidae [1]).

Bicellariidae Hincks, 1880, BMP, p. 64; et auctt.
Bicellariidae (pars) Levinsen, MSSB, pp. 88, 93.
Bicellariellidae Levinsen, op. cit., p. 431.

The members of this Family are typically Cellularine in habit, consisting as a rule of erect, much branched zoaria, unilaminar and for the most part biserial. An encrusting habit is found in certain species of *Beania*. The zooecia are in most cases elongate and turbinate, their proximal ends frequently forked and equitant on the basal surfaces of their predecessors, which

1) For this form of the Family name see under *Bicellariella*.

they thus overlap. A division of the zooecia into three sections may occur, as in the Euoplozoidae and Epistomiidae. The amount of calcification may be reduced, the zoarium then having a very delicate texture. The opesia and frontal membrane are generally extensive, and the operculum is not always differentiated from the frontal membrane. Many species have a well marked gymnocyst, and the cryptocyst is at most feeble. Marginal and oral spines are of common occurrence. The avicularia give the most important character, being (except in *Himantozoum*) all pedunculate, usually with an aquiline beak and invariably with acute rostra and mandibles. The Family thus differs from the Epistomiidae, in which, although pedunculate avicularia have made their appearance, they are usually accompanied by sessile avicularia, resembling those of the Scrupocellariidae. Pedunculate avicularia are also found in certain Membraniporine genera, as in *Cauloramphus* Norman (1903, AMNH, 7, XI, p. 587); and it is not unlikely that Membranimorphs of this type have given rise to the Bicellariellidae. The majority of the species have prominent, free, hyperstomial ovicells. Each lateral wall typically possesses a single rosette-plate in its distal half. These are not always easily seen; but, according to Levinsen (p. 94), they are usually multiporous.

It seems probable that *Beania*, which is commonly more or less encrusting, retains a more primitive habit than the other genera of the Family. The zoarium in this genus may be encrusting and unilaminar, but the zooecia have typically become discontinuous, the unions with their neighbours being drawn out into shorter or longer connecting tubes (usually 6 or 4), separated by fenestrae. Zooecia of this type have been described on p. 235, under *Hiantopora*, which I have placed in the Membraniporine assemblage. Most of the connecting tubes may disappear, however, and with them the fenestrae.

Certain species of *Beania* are thus ramified, in varying degrees, as in the other genera, and no longer possess connecting tubes, other than the junctions with their neighbours in the same longitudinal row. I have previously suggested (1923, JLS, XXXV, p. 321) that the members of this and of other Families with a Cellularine habit are to be regarded as unilaminar sheets, more or less subdivided by radial slits open at the distal end; and on this conception they can be derived from ancestors of the more primitive, unilaminar and encrusting type. I have pointed out in the same place that the mode of bifurcation in this Family, as in others, affords valuable characters by which to distinguish genera and species.

Levinsen (1909) has ascribed much wider limits to the Family than those I accept, including in it various genera which seem to me to deserve places elsewhere.

Calyptozoum, a new genus described below, is in some respects one of the most interesting forms obtained by the Siboga.

1. **Beania** Johnston.

Beania Johnston, 1840, Annals of Nat. Hist., V, p. 272; — 1847, HBZ, p. 371.
Beania Levinsen, 1909, MSSB, pp. 88, 97, 110.
Diachoris Busk, 1852, VR, p. 381; — 1852, BMC, p. 53.
Diachoseris (errorim) Ortmann, 1889, ANG, LVI, 1, p. 25.
Chaunosia Busk, 1867, QJMS, N. S., VII, p. 241.
Monotypical. Genotype, *Beania mirabilis* Johnston, 1840.
See Harmer, 1923, JLS, XXXV, pp. 298—306, for this and the other genera mentioned above.

Zooecia with a narrow, tubular, proximal end, expanded distally, generally united with 6 or 4 other zooecia by connecting tubes separated by smaller or larger fenestrae; sometimes not thus united; their proximal ends not equitant on the distal portions of their predecessors. Opesia occupying the entire front of the expanded portion, more or less surrounded by spines, or without these structures. Operculum differentiated from the frontal membrane. Pedunculate avicularia usually present, in some species wanting. Ovicells present, or vestigial, or wanting.

MacGillivray (1882, PRSV, XVIII, p. 115) called attention to the resemblance of *Diachoris* to *Beania*, a genus which has a well marked character, although spines, connecting tubes and fenestrae, avicularia and ovicells are sometimes wanting. It is unfortunate that the type-species is deficient in most of these attributes of *Beania*, and I regard it as probably the most highly modified (and reduced) member of its genus. The expanded distal ends of the zooecia have often been described as "boat-shaped", a term which well expresses their shape. They differ widely from the turbinate zooecia of other genera.

It may be presumed that the ancestors of *Beania* had continuous zooecia, provided with paired avicularia, marginal spines and six rosette-plates. By the partial separation of the zooecia, fenestrae made their appearance, and the portions bearing the rosette-plates became prolonged into cylindrical tubes, at first short; the typical arrangement, with 6 connecting tubes, being thus evolved. Certain species may be supposed to have lost a pair of connecting tubes, leaving only 4, as in *B. regularis*; while the arrangement found in *B. mirabilis* would be acquired by the further loss of another pair. Avicularia or spines, or both, have been lost in certain species; and the ovicells have usually become vestigial or have altogether disappeared.

Key to the species of *Beania* here described.

1	Zoarium reticulate, with closed fenestrae between the connecting tubes	2
	Zoarium not reticulate	7
2	Connecting tubes six	3
	Connecting tubes four, the fenestrae quadrangular, much wider than the zooecia. Avicularia proximal and lateral, frequently wanting	6. *B. regularis.*
3	Zoarium a unilaminar sheet. Avicularia distal	4
	Zoarium Cellariiform, with long, free branches, bifurcating at intervals, the zooecia with numerous branched spines. Avicularia wanting	5. *B. hirtissima*, var. *cylindrica.*
4	Frontal spines wanting or vestigial	5
	Frontal spines well developed	6
5	Opesia symmetrical. A pair of distal avicularia	1. *B. magellanica.*
	Opesia very asymmetrical distally, the orifice pushed to one side, to make room for a large avicularium with elongate rostrum, curved laterally	2. *B. asymmetrica.*

6	Avicularia unilateral or paired, moderately large, the head globose proximally, the rostrum elongate, with a very concave upper profile	3.	*B. discodermiae.*
	Avicularia paired, small, the proximal end narrow and tubular, the rostrum very short, with nearly straight upper profile	4.	*B. petiolata.*
7	Proximal part of the zooecium very short, tubular, much shorter than the expanded part. A pair of distal avicularia, with short rostrum	7.	*B. cupulariensis.*
	Proximal part of the zooecium a narrow cylindrical tube, usually longer than the expanded part. Avicularia wanting	8.	*B. mirabilis.*

(*a*) Connecting tubes 6.

1. *Beania magellanica* (Busk). (Pl. XXVIII, figs 1—4; text-fig. 21). (Not in the Siboga Collection).

Diachoris magellanica Busk, 1852, BMC, p. 54, Pl. LXVII, figs 1—3, Straits of Magellan, New Zealand. Type-locality, Straits of Magellan, as shown by the slide 54. 11. 15. 100 (Brit. Mus.), indicated by BUSK as the original of his Pl. LXVII.
Diachoris magellanica Waters, 1879, AMNH, 5, III, p. 120, Pl. XII, fig. 1. Naples. 30—50 fath.
Diachoris magellanica Busk, 1879, PTRS, CLXVIII, p. 194. Kerguelen.
Diachoris magellanica MacGillivray, 1880, PZV, V, p. 32, Pl. XLVI, figs 2—2*b*. Victoria.
Diachoris magellanica Waters, 1885, JRMS, 2, V, Pl. XIV, fig. 4 (mandible).
Diachoris magellanica Hincks, 1885, AMNH, 5, XV, p. 246, Pl. VIII. figs 2*a*—*d*.
Diachoris magellanica Jullien, 1888, CH, p. 72, Pl. XI, figs 1—3, Pl. XII, fig. 3 (avicularium). Tierra del Fuego, Mauritius, S. Africa, Cape Verde Is, Japan, Mediterranean.
Diachoris buskei Heller, 1867, VZBGW, XVII, p. 93. Adriatic.
Diachoseris magellanica Ortmann, 1889, ANG, LVI, 1, p. 25, Pl. I, fig. 22. Japan, 100 fath.
Beania magellanica MacGillivray, 1890, PZV, Vol. II, Prefatory Note, after Index.
Beania magellanica Waters, 1897, JLS, XXVI, p. 16, Pl. II, figs 11—15 (fig. 15 wrongly ascribed in the explanation of the Plates). Rapallo, Port Jackson.
Beania magellanica Waters 1904, BB, p. 28, Pl. VIII, figs 7*a*—*c*. Straits of Magellan.
Beania magellanica Calvet, 1904, HMS, p. 8. Tierro del Fuego, Falkland Is.
Beania magellanica Waters, 1906, AMNH, 7, XVII, p. 14, Pl. I, fig. 22 (mandible). D'Urville Id, New Zealand.
Beania magellanica Calvet, 1907, BTT, p. 392. Cape Verde Is.
Beania magellanica Kluge, 1914, BDSE, p. 648, Text-fig. 29*a*. Kerguelen.
Beania magellanica Yanagi and Okada, 1918, AZJ, IX, p. 427. Japan.
Beania magellanica Marcus, 1922, SAB, p. 4, text-fig. 1. S. Africa.
Beania magellanica O'Donoghue 1924, BP, p. 33. S. Africa.

Cambridge, Mus. Zool.: —

BM Torres Straits, 140, A. C. HADDON, Reg. Feb. 24, 1898.
BM Japan, 48. C, off Tokyo, 20—30 fath., A. OWSTON, Reg. June 23, 1902.
Naples, S. F. HARMER, 1891.

Zooecia forming a network with large meshes, adherent to the substratum by wide rootlets, one given off by each zooecium on its basal side, in the middle line, near the distal end. Spines vestigial, confined to the region of the orifice, where 4 may occur. Avicularia very large, a pair

on each zooecium, the stalks given off on the frontal side of the distal lateral connecting processes; the rostrum more or less compressed, strongly hooked, its edge often denticulate. Ovicells vestigial.

B. magellanica may be regarded as a southern species, circumpolar in its distribution, which has extended its range across the Equator as far north as the Mediterranean and Japan. In the original account BUSK described its orifice as "circular with a thickened and raised margin". As pointed out by WATERS (1879) and HINCKS (1885), this appears to have been due to the fact that the operculum is often thrown back so that its convex distal border lies proximally; thus, with the actual orifice, completing a circle. Two pairs of minute oral spines may occur, two distally and the other two at the sides of the orifice; and are just distinguishable in the specimen from Torres Straits. In most cases the avicularian rostrum is very narrow and compressed, but in the specimens from Japan (figs 1—4) it is somewhat wider. Its margins, particularly the outer one, in the present material, are strongly denticulate, as mentioned by ORTMANN. KLUGE (1914) expressed the opinion that this character entitles the Japanese form to be considered a variety, the typical form of the species having the margin smooth. I do not think this difference important, as I find a slight beading of the rostral edge in the specimen from Naples, and this may represent the more definite denticulation of Japanese specimens. KLUGE includes the Neapolitan form in his synonymy of the typical form, as shown by his citation of WATERS (1879). The mandible has a pair of strongly marked, short, longitudinal sclerites at its proximal end (fig. 1), as figured by WATERS (1906).

The origin of the single, wide, chitinous rootlet is shown in figs 1, 2. The zooecia are normally alternate, the proximal lateral connecting tube (text-fig. 21, 1) meeting the distal lateral tube (2) of an adjacent zooecium. They occur in longitudinal rows, but an additional row is intercalated when a distal lateral connecting tube of a parent zooecium passes into the median proximal tube of a daughter-zooecium (AE, EF). A series of zooecia in a longitudinal row may behave successively in this way, the zooecia forming the commencements of new rows being either on the same sides of the main row, or on opposite sides. Thus, in the figure, the row EG is given off from the left side of A, and a new row (F) starts on the right side of E.

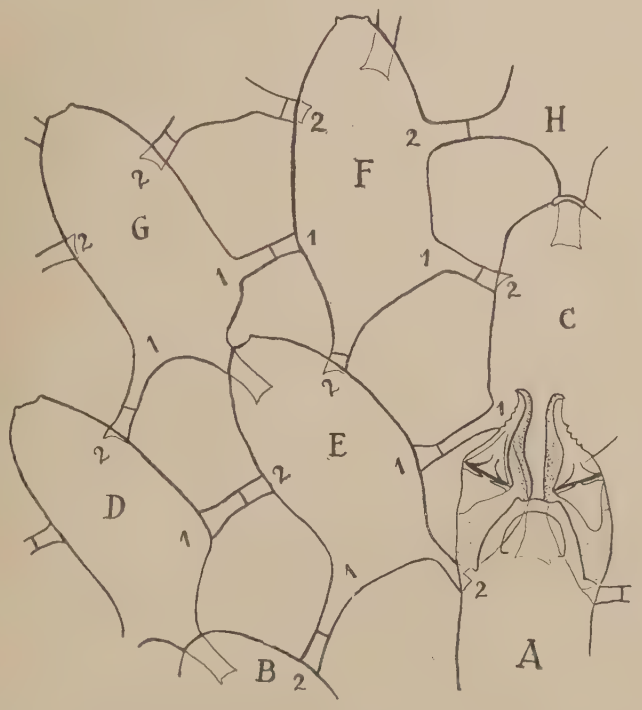

Fig. 21. — *Beania magellanica*. Part of zoarium (Cambridge, Mus. Zool., Japan, 48. C), to show the method of branching of the rows of zooecia. The avicularia are represented on the zooecium A, and a vestigial ovicell in C. 1 and 2 are the proximal and distal lateral connecting processes, respectively. For lettering, see text. Obj. A, reduced $^3/_4$.

The ovicells (figs 2, 3) are extremely vestigial and are incapable of receiving the large egg, which occupies a considerable proportion of the body-cavity in the specimen from Naples

and in another (86. 8. 27. 523) from Port Jackson in the British Museum (see also Waters, 1912, AMNH, 8, IX, p. 493 n. and Marcus, 1922). In basal view (fig. 2) the ovicell appears as a small crescentic appendage at the distal end of the gonozooecium. In frontal view (fig. 3) the two layers of the ovicell are readily seen, and the rest of the ovicell can be observed, through the transparent distal end of the zooecium, on the basal side. It is here prolonged into a delicate tube (fig. 2, *t*), which passes proximally along the basal wall of the gonozooecium to the commencement of its median distal connecting tube, along the frontal wall of which it is reflected as far as the septum which divides the two zooecia. The whole course of this communication can also be seen from the frontal side, in a transparent preparation (fig. 3). The hyperstomial ovicell of a Cheilostome is normally formed with the aid of a contribution from the zooecium which succeeds the gonozooecium in the same longitudinal row (see p. 203 and text-fig. 1 C), and I regard the delicate tube above described as a vestige indicating the participation of the distal zooecium in the formation of the ovicell of *Beania*.

2. *Beania asymmetrica* n. sp. (Pl. XXVIII, figs 5—8).

324. B. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
Type. 327. A. Stat. 64. Tanah Djampeah, between Flores and Celebes, 0—32 M.
66. A. Stat. 99. North Ubian, Sulu Archipelago, 16—23 M.
292. C. Stat. 273. Jedan, Aru Is, 13 M.

Zoarium reticulate, forming large sheets of *Flustra*-like appearance; the fenestrae oval, much smaller than the zooecia. Basal surface bearing pointed, calcareous spines. Proximal part of zooecium very short; and, like the lateral connecting tubes, relatively broad. Expanded part constituting nearly the whole zooecium, the opesia large and broad, extremely asymmetrical at its distal end, the orifice on a unilateral lobe of the frontal membrane. On the other side the opesia does not extend so far distally, the zooecium here carrying an elongate avicularium, with a globose head and an extremely long, narrow rostrum, curved laterally, with its concave side towards the orifice. The outer cutting edge of the rostrum is usually strongly denticulate. Marginal and oral spines wanting. Ovicells large, two-layered, projecting considerably above the plane of the frontal membrane.

In general appearance *B. asymmetrica* resembles *Flustra foliacea*, reaching a length of at least 50 mm. and bifurcating several times, much as in that species. The unilaminar zoaria were found on the surface of mud or sand, to which they appear to be attached by the basal spines; rootlets of the ordinary *Beania*-type being wanting. The striking asymmetry of the distal end (fig. 5) is correlated with the presence of the large avicularium, which is attached by a delicate peduncle to a shoulder of the zooecium. On the opposite side the frontal membrane extends distally as a unilateral lobe, of about half the width of the rest of the zooecium and carrying the orifice, which is displaced from the middle to one side.

The avicularium (figs 5, 7) has a conspicuous proximal foramen, continuous with the distal end of its peduncle, and its opesia extends over most of the frontal surface. The transverse calcareous bar is incomplete, the base of the mandible articulating with a pair of lateral condyles. The rostrum is narrow, and the mandible is linear distally, for more than half its length, the terminal spike rather small and triangular.

B. asymmetrica is of special interest in possessing well developed and very prominent ovicells (figs 5, 8), the ectooecium and entooecium separated by a considerable interval, and many of them containing a large embryo. In fig. 5, from a Canada balsam preparation, the form of the frontal wall was not ascertained satisfactorily. On the basal side, as indicated in the lowest ovicell, the wall of this structure is produced proximally into a wide sinus, which ends blindly, without having a tubular connexion with the succeeding zooecium, of the kind found in *B. magellanica*. In a dry preparation (fig. 8) the ovicell was shown to be longer than wide, becoming narrower proximally, where its free edge had been drawn over the frontal surface by the contraction of the zooecium in drying. In its natural position the free, narrow proximal lip is more vertical, and the wall of the ovicell curves up distally.

Waters (1889, AMNH, 6, IV, p. 4, Pl. II, fig. 14) described and figured well developed ovicells in an Australian form recorded by him as *B. hirtissima*, var. *conferta*; and he stated that this is the only species of *Beania* in which he had certainly recognised an ovicell.

The number of tentacles appears to be not less than 20—22.

3. *Beania discodermiae* (Ortm.). (Pl. XXVIII, figs 9, 10).

Diachoseris discodermiae Ortmann, 1889, ANG, LVI, 1, p. 26, Pl. I, fig. 23. Japan.

488.H. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M.
138.B. Stat. 164. W. of N. end of New Guinea, 32 M.

Zoarium reticulate, the fenestrae moderate but narrower than the zooecia, which do not overlap their neighbours. Connecting tubes relatively narrow. Expanded part constituting nearly the whole zooecium, the opesia large and oval, widest at the middle, narrowest distally, where it is not asymmetrical. Distal spines usually 3, occasionally 4. Another pair occurs at the sides of the orifice, and there are 5—11 spines on each side, on the proximal side of the avicularia. Avicularia on one or both sides, just on the proximal side of the operculum, with a globose head, not compressed, and a narrow, symmetrical rostrum, which varies greatly in length. The upper profile is very concave, the rostrum strongly hooked distally, its outer cutting edge sometimes slightly denticulate. A basal rootlet is given off in the middle line, near the level of the distal lateral connecting tube, and there is commonly a lateral rootlet on the proximal side of the proximal lateral connecting tube, on one or both sides. Vestigial ovicells as in *B. regularis*.

B. discodermiae resembles *B. asymmetrica* in habit and in the position and form of the avicularia, but differs from it by its symmetrical opesia and avicularia, by the presence of frontal spines and of typical rootlets instead of the spines found in that species.

The ordinary spines, which are unjointed, are directed outwards or overarch the frontal membrane. The avicularia are very variable in length in the same colony, the rostrum being hardly longer than the head or much longer. The distal end is bent at right angles into a very prominent hook, and the mandible has a strong terminal spike. When elongated, the rostrum is very narrow distally. The calcareous bar is usually complete, and the proximal opesia of the avicularium has a slight cryptocyst proximally. The median and lateral rootlets have the chitinous constitution found in most other species of *Beania*.

A few zooecia have vestigial ovicells resembling those of *B. regularis*, but the ovicell is two layered, as in *B. magellanica*. The median distal spine is wanting in the gonozooecia, and the ovicell is related to the first pair of spines in the same way as in *B. regularis*. The proximal basal wall of the ovicell is transversely curved or straight and is not produced into a fine tube of the kind found in *B. magellanica*. The tentacles are about 24. The caecum of the polypide is large and is directed transversely, on the basal side of the tentacles, during retraction.

B. discodermiae has some resemblance to *B. spinigera* MacGillivray (1880, PZV, V, p. 32, Pl. XLVI, figs 3—3*b*), but its avicularia are differently shaped and the distal spines are shorter.

4. *Beania petiolata* n. sp. (Pl. XXVIII, figs 18, 19).

Type 108.AE., 394. F. } Stat. 144. S. of Halmaheira (Djilolo), 45 M.
666.A. Stat. 164. W. of N. end of New Guinea, 32 M.

Zoarium reticulate, the fenestrae moderate, narrower than the zooecia, which do not overlap their neighbours. Connecting tubes relatively narrow. Expanded part constituting nearly the whole zooecium, the proximal part shortly tubular. Opesia symmetrical, large and oval, varying in its proportions, usually widest at the middle or in the proximal half, becoming narrower distally. Spines more numerous than in *B. discodermiae*. Avicularia small, usually two on each zooecium, at the sides of the orifice; the proximal part narrow and tubular (hence the trivial name), the head short with upper and lower outlines nearly parallel, the rostrum short and slightly hooked, the mandible shortly triangular with a terminal spike, the peduncle moderate. Median basal rootlet given off on the proximal side of the distal lateral connecting tube; a proximal lateral rootlet, situated as in *B. discodermiae* or, occasionally, a median proximal rootlet. A pair of spines usually present at the distal end of the basal surface. Ovicells not found.

B. petiolata is only represented by fragments, one of which was loosely attached to a calcareous Alga. It has some resemblance to *B. discodermiae*, from which it is distinguished by the more numerous frontal spines, by the occurrence of spines at the distal end of the basal surface, and above all by the entirely different avicularia (fig. 19). There are generally 4, 5 or more distal frontal spines, and a number of pairs of overarching lateral marginal spines. In addition to these there are others, arising slightly more basally, which are directed outwards. These may have an independent origin, but in other cases three or even four spines arise from the same base, one overarching the opesia and the others more or less vertical or directed outwards. These may probably be regarded as together constituting a branched spine. The two distal basal spines are moderately constant, but there may be at least one other in the same neighbourhood. The small avicularia are very characteristic, the narrow proximal end and the form of the head contrasting strikingly with the form of the avicularia in *B. discodermiae*. They resemble the avicularia of *Diachoris elongata* Hincks (1885, AMNH, 5, XV, p. 244), but are relatively smaller and are situated more distally. The spines described by Hincks are, moreover, a single series on each side, overarching the opesia.

The polypide is large, filling most of the body-cavity, and the tentacles are about 20.

5. *Beania hirtissima* (Heller), var. *cylindrica* Hincks. (Pl. XXVIII, figs 16, 17).

Chaunosia hirtissima Busk, 1867, QJMS, n. s., VII, p. 241, Pl. XXXVI, figs 12—16. Cape of Good Hope (nec *Diachoris hirtissima* Heller).
Diachoris hirtissima, form *cylindrica* Hincks, 1886, AMNH, 5, XVII, p. 263. Adriatic, Cape Verde Is.
Beania hirtissima, var. *cylindrica* Waters, 1889, AMNH, 6, IV, p. 4 n. Naples.
Beania hirtissima, form *cylindrica* Kirkpatrick, 1890, TS, p. 611. Torres Straits.

331.A. Stat. 64. Tanah Djampeah, between Flores and Celebes, 0—32 M.
67.D. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.

Zoarium erect, Cellariiform, 4-serial, reaching a length of at least 30 mm., composed of narrow, linear branches, about 1.5 mm. in diameter and bifurcating at intervals of about 9—10 mm. Connecting processes short and wide. Fenestrae elongate, much narrower than the zooecia. Opesia an elongated oval, narrower distally. Cryptocyst well developed proximally and laterally, as a narrow shelf, in the older zooecia. Spines very numerous, many of them branched, some of the branches overarching the opesia, others vertical or directed outwardly or basally. Distal spines numerous. A branched spine usually present, on each side, on the basal side of the distal end of the zooecium. Avicularia and ovicells not found.

Diachoris hirtissima was described by Heller (1867, VZBGW, XVII, p. 94, Pl. I, figs 6, 7) from the Adriatic; his figures, which represent the unilaminar form, being unsatisfactory. *Chaunosia hirtissima* was introduced, in the same year, by Busk, who expressed a doubt whether his trivial designation was new, taking into account the possibility that his specimens might be referable to Heller's species. The zoarium was described by him as having "narrow ligulate, or subcylindrical, irregularly dichotomous, lax branches", and he mentioned branched spines, which are similar to those found in the Siboga specimens. Waters (1897, JLS, XXVI, p. 18) suggested, I think correctly, that Hincks' var. *cylindrica* is identical with *Chaunosia hirtissima* Busk; and, in his Cape Verde paper (1918, JLS, XXXIV, p. 8) he gives a synonymy of *B. hirtissima* which may be consulted with advantage.

This form, which has large and robust zooecia, is differentiated by its Cellariiform habit from all the other species obtained by the Siboga. The zooecia, which alternate as usual, give off their lateral connecting tubes more basally than in other species, in correlation with their arrangement round the axis of the branch, which shows two rows of zooecia whether regarded in lateral view or seen as lying in the plane of a bifurcation. It is thus not possible to distinguish between frontal and basal surfaces of the branch. The spines appear to be very numerous, owing to the fact that a large proportion of them are branched (fig. 16). The subdivision may take place from the base, but there is commonly a short, vertical, common base, from the end of which the branches are produced. In the fully developed spine there are usually six branches, of which two form a fork, the base of which lies in the plane of the lateral edge of the zooecium, the two branches curving over the opesia (fig. 17). The other four branches diverge to form a transverse, vertical row, so that the lowest branch is directed along the side of the zooecium, towards the basal surface. 67. D. has broader zooecia and much coarser spines than 331. A, which it resembles in other respects. Median or lateral, chitinous, branching rootlets may be given off from the proximal end of a zooecium. Avicularia seem to be completely absent and ovicells have not been proved to exist.

(*b*) Connecting tubes 4.

6. *Beania regularis* Thornely. (Pl. XXVIII, figs 11, 12).

Beania regularis Thornely, 1916, POK, p. 161, text-fig. 6. Kattiawar (N. W. India).
Beania ostia Robertson, 1921, BBB, p. 38, text-fig. 2. Gopalpore, E. coast of India, 25—28 fath.

322. C. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
37. E. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
55. A. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
490. A. Stat. 144. S. of Halmaheira (Djilolo), 45 M.
396. N. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
122. A.) 138. E.) Stat. 164. W. of N. end of New Guinea, 32 M.
299. B. Stat. 273. Jedan, Aru Is, 13 M.
198. B. Stat. 274. Off Jedan, Aru Is, 57 M.

Zoarium reticulate, forming large, open, quadrangular meshes, one of the normal lateral pairs of connecting tubes wanting; adherent by rootlets given off by the basal surface, normally one by each zooecium, near the proximal end of its expanded part, occasionally two, or even three, all median. Spines small, restricted to the oral region, usually three distally, occasionally two or four, in addition to one on each side of the orifice. Opesia occupying the entire front of the expanded part, widest proximally, its sides nearly straight; the proximal part of the zooecium long and tubular. The lateral connecting tube arises in the proximal half of the expanded part. Avicularia paired, near the proximal end of the opesia, sometimes on one side only, and not found in most of the specimens. Ovicells vestigial.

The Siboga specimens closely resemble those described by Miss Thornely, who observed no avicularia, and by Miss Robertson, who found only a single avicularium. These structures are moderately plentiful in 122. A (fig. 11), but not by any means on all the zooecia and often on one side only; but I have not found them on any of the other specimens. The avicularium has a peculiar form (fig. 12), the hooked end of the rostrum being broad at its base, and the mandible, which is very short, having the usual terminal spike. The species, which appears to be common in the Archipelago, is easily recognisable by its regular quadrangular meshes. These ordinarily occur between longitudinal rows of zooecia, but sometimes, where a new row is intercalated, as in the avicularium-bearing individual of fig. 11, a zooecium appears to have two proximal connecting tubes.

A few zooecia have a rounded distal end without spines, as in the avicularium-bearing individual of fig. 11. Two spines occur on each side of the orifice, and the basal surface of the zooecium is crossed, distally, by a curved line, convex towards the proximal end, uniting the bases of the distal spines. This arrangement was described by Miss Robertson, who suggested that the structure thus outlined might be a vestigial ovicell, a view which is confirmed by the evidence of other Siboga species. I have not been able to find ovaries, nor a tube running proximally from the ovicell, as described in *B. magellanica*.

The expanded parts of the zooecia stand up at a considerable angle from the basal network formed by the connecting tubes, and are thus outside the plane of this part of the colony. The origin of the basal rootlets is indicated by circles in fig. 11. The tentacles are 24—26.

(*c*) Lateral connecting tubes not fully developed, zoarium not reticulate.

7. *Beania cupulariensis* Osburn. (Pl. XXVIII, figs 13, 14).

Beania cupulariensis Osburn, 1914, CIW, 182, p. 190, text-figs 6, 7. Tortugas Is (Florida), 10—22 fath.

62. P. Stat. 99. North Ubian, Sulu Archipelago, 16—23 M.
371. F. Stat. 273. Jedan, Aru Is, 13 M.

Zoaria uniserial, not reticulate, the proximal, tubular portion so short as not to extend beyond the distal end of the preceding zooecium. Distal portion large, the opesia occupying its entire front and surrounded by a series of spines on each side, in addition to a pair of distal spines, set close together. Avicularia paired, at the sides of the orifice; with a short rostrum. Ovicells not found.

The material is very scanty and the two specimens are unlike. 62. P (fig. 14) consists of relatively broad, rather shallow zooecia, the opesia being surrounded by two series of lateral, uniformly spaced spines, of which there are 7—9 on each side, originating just outside the rim of the opesia. There are, in addition, a pair of distal spines, situated close to one another. The operculum is of the usual type, with no basal sclerite. At its sides are a pair of avicularia, with short stalks and a short, hooked rostrum. The terminal spike of the mandible (fig. 13) is strong. The proximal end of the zooecium, constituting the median connecting process, is extremely short, and is completely overlapped by the distal end of the preceding zooecium. A pair of lateral connecting processes is represented, not always opposite one another, but the corresponding zooecia are usually wanting and have possibly been lost. Fig. 14 shows one of the lateral zooecia, in which the proximal portion is as short as in the zooecia produced distally. A median rootlet is given off basally, in the neighbourhood of the vestigial, lateral connecting processes. The tentacles are about 20, and there are 4 pairs of strong depressor muscles, the distal pair at the level of the origin of the occlusor muscles and the others evenly spaced in the more proximal part of the zooecium.

371. F consists of only three zooecia, which are longer and narrower than those of 62. P. The lateral spines, 3—4 on each side, are not nearly so well developed, being shorter and less numerous than in 62. P. The different proportions of the zooecia and the difference in the spines give the two specimens a very dissimilar appearance. They agree, however, in the number and position of the connecting processes, in the two distal spines and in the position and form of the avicularia. I think they should be referred to the same species, and that the number of the spines, as in *B. mirabilis*, is not constant.

The agreement between 62. P and Osburn's *B. cupulariensis*, which was always found on the basal surface of *Cupuladria guineensis*, is very close.

8. *Beania mirabilis* Johnston. (Pl. XXVIII, fig. 15).

Beania mirabilis Johnston, 1840, Ann. Nat. Hist., V, p. 272, text-figs 1, 2; — 1847, HBZ, p. 372, text-figs 69, 70. Britain.
Beania mirabilis Busk, 1852, BMC, p. 32, Pl. XXIV, figs 4, 5. Britain.
Beania mirabilis Hincks, 1880, BMP, p. 96, text-figs on pp. XXI, 66, Pl. IV, figs 8—10; — 1884, AMNH, 5, XIII, p. 357. Mergui Archipelago (Burma).

Beania mirabilis MacGillivray, 1886, PZV, XII, p. 63, Pl. CXVI, figs 1, 1*a*. Victoria.
Beania mirabilis Waters, 1879, AMNH, 5, III, p. 117. Naples. — 1897, JLS, XXVI, p. 17, Pl. II, fig. 1. Rapallo; — 1913, BEA, p. 467. Zanzibar.
Beania mirabilis Jullien and Calvet, 1903, BCH, p. 38. Azores.
Beania mirabilis Robertson, 1905, NCNA, pp. 237, 276, text-fig. 1 (p. 238), Pl. XII, figs 63, 64. California.
Beania mirabilis Thornely, 1905, PGM, p. 109. Ceylon.
Beania mirabilis Barroso, 1912, TMCNM, 5, p. 17. Santander (N. Spain).
Beania mirabilis Osburn, 1914, CIW, 182, p. 189. Tortugas Is (Florida).

67. H. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M.

Cambridge, Mus. Zool.: —

Torres Straits, 119. A. C. HADDON, Reg. Feb. 24, 1898.

Zoarium uniserial, not reticulate. Zooecia elongate, narrow and tubular proximally and here long, expanding distally, the opesia occupying the entire front of the distal portion. The distal successor is given off on the basal side of the proximal half of the expanded region, close to the proximal end of which are a pair of lateral connecting tubes, each giving rise to a zooecium. A median rootlet originates on the proximal side of the lateral connecting tubes. Expanded part (in the Siboga and Torres Straits specimens) dilating gradually from the proximal part and then remaining of uniform diameter throughout, its sides straight and parallel. Two pairs of short oral spines and 4—6 pairs (usually 5 pairs) of short spines at the sides of the opesia, which they overarch. Avicularia and ovicells not known.

B. mirabilis, the type-species of *Beania*, shows the extreme amount of reduction found in the genus, the reticulate character having disappeared, and avicularia and ovicells being wanting. The specimens examined consist of six zooecia from Stat. 99 and two zooecia from Torres Straits. They differ from those figured by JOHNSTON and HINCKS in being of uniform diameter throughout the distal region, the British specimens being wider at the commencement of this part than at the distal end. In a specimen in the Cambridge collection from Rapallo I find the same difference, and there are 11 pairs of lateral spines, in addition to the two pairs of oral spines. JOHNSTON figured a number not exceeding that of the Siboga specimens, and it may be concluded that the number of the spines is not constant. The lowest zooecium in fig. 15 has only one spine, in addition to the 4 oral spines.

The operculum is Membraniporine, with no basal sclerite, and has a pair of lateral, triangular flanges for the insertion of the occlusors. The vestibule of the polypide is rather conspicuously long, and the tentacles seem to be about 12. HINCKS (1880, p. 97) gave the number as 20.

2. **Bicellariella** Levinsen.

Bicellaria (pars) de Blainville, 1830, DSN, p. 423; — 1834, MA, p. 459.
Bicellaria (pars) Hincks, 1880, BMP, p. 66; et auctt.
Bicellaria Levinsen, 1909, MSSB, pp. 99, 110.
Bicellariella Levinsen, op. cit., p. 431.
Bicellariella Harmer, 1923, JLS, XXXV, p. 299.
Genotype, *Sertularia ciliata* Linn., 1758, SN., p. 815 (see LEVINSEN, p. 110).

In 1909 LEVINSEN (pp. 99, 110) broke up the old genus *Bicellaria* into the three genera *Bicellaria* (*s. str.*), *Bicellarina* and *Cornucopina*. In his Index, p. 431, he pointed out that *Bicellaria* de Blainv. is pre-occupied by *Bicellaria* (Diptera) Macquart, 1823, and he accordingly replaced it by *Bicellariella*, with the corresponding Family Bicellariellidae.

As defined by LEVINSEN, the characters of *Bicellariella* are: — zooecia divided into three sections, of which the distal one is obliquely funnel-shaped; basal edge of the distal wall unequally asymmetrical and angular; avicularia movable; rootlets issuing from the basal wall of the zooecium; and ovicells originating from the boundary between two zooecia of a longitudinal row. It may be added that the turbinate zooecia are typically provided with numerous oral and marginal spines. The division of the zooecia into three sections is also characteristic of the Euoplozoidae and the Epistomiidae.

1. *Bicellariella levinseni* n. sp. (Pl. XXXI, figs 17, 18).

Type. 16.D. Stat. 49a. Sumbawa, E., 69 M.
37.ZE. Stat. 77. Borneo Bank, Strait of Makassar, 59 M. One colony, juv.

Zooecia divided into three well marked sections, by two joints; the distal section turbinate, moderately prolonged outwards. Spines long, jointed at the base, 4—6 in the distal series, 2—3 on the proximal side of the opesia, which is circular or ovoid, in the latter case often rather narrower proximally. Avicularia on the middle sections of the zooecia, small. Ovicells typically broader than long.

This species is named in honour of LEVINSEN, who was the first to subdivide *Bicellariella*. It differs from *B. ciliata* (L.) in having the distal part of the zooecium less thrown outwards, and from this species and *B. capensis*[1]) (O'Donoghue) (1924, BP, p. 32) in the occurrence of the avicularia on the middle section instead of on the third section of the zooecium. It appears to be allied to *B. turbinata* (MacGillivray) (1869, PRSV, IX. p. 129; — 1881, PZV, VI, p. 39), but differs from it in the number and arrangement of the spines, while MACGILLIVRAY does not mention avicularia, which are a conspicuous feature of the Siboga species. *B. gracilis* (Busk) (1852, VR, p. 374; — BMC, p. 42) is another related species.

The avicularium (figs 17, 18) is articulated to a cylindrical process of the middle section of the zooecium, between the two joints. The two layers of the ovicell, which lies directly over the first section of a zooecium, are closely approximated, and the aperture faces basally.

The mode of bifurcation is essentially as in *Caulibugula dendrograpta*, as represented in Pl. XXXIII, fig. 2. The axillary zooecium (E) barely projects into the axil and it differs from the ordinary zooecia in the symmetry of its opesia and spines. One spine is median and basal, near the distal end; three are frontal, one of them median and distal, and the other two placed symmetrically at the sides of the opesia. E possesses the usual two joints, but it bears no avicularium. The first section of G is strongly forked, as in Pl. XXXIII, fig. 2, passing across E just proximally to its basal spine. Its relations to other zooecia are precisely as in *C. dendrograpta*, except that the inner limb of the fork joins F distally to the joint and near its proximal end.

1) *B. capensis* seems to be a synonym of *B. chuakensis* (Waters) 1913, BEA, p. 467.

3. Cornucopina Levinsen. (Pl. XXIX).

Cornucopina Levinsen, 1909, MSSB, pp. 98, 109.

Genotype, selected by Harmer, 1923, JLS, XXXV, p. 306, *Bicellaria grandis* Busk, 1852, VR, p. 374; — 1852, BMC, p. 42.

This genus was characterised by Levinsen as follows: — Zooecia very asymmetrical, the narrow proximal part widening into an obliquely funnel-shaped extremity furnished with spines. Avicularia usually present. Rootlets issue from rosette-plates, situated basally, "a good way distally", and pass down the basal surface of the colony. Ovicells on the distal margin of zooecia of ordinary size, surrounded by kenozooecia. The colonies are elegant tufts with biserial branches.

The above diagnosis hardly does justice to the striking features of *Cornucopina*, and attention may be called to the following additional points. — The axis of the biserial branch is very slender and is composed of the proximal narrow ends of the alternating zooecia, which project more or less strongly from the axis and are greatly expanded distally. The zooecium is divided by a joint into two sections, the proximal one very short. The lateral rosette-plates between adjacent zooecia are extremely conspicuous and project like watch-glasses from the median septal wall of the axis. The spines are highly developed, very long, jointed at the base, some of them being carried, in most species, by a digitiform process given off from the distal end of the zooecium. The operculum is Membraniporine. The avicularia are multiform, even in the same species, and are often extremely elongated and even gigantic. The ovicells are hyperstomial and typically large.

According to Levinsen, *Cornucopina* includes "the majority of the species in the old genus *Bicellaria*". It appears that the only species actually examined by him were *B. grandis* and *B. infundibulata*, both figured by him in Pl. IV. Of these, *C. grandis*, the genotype, appears to possess a well developed cryptocyst (Harmer, 1902, QJMS, XLVI, p. 290). Its ovicell has been figured by Goldstein (1882, PRSV, XVIII, Pl. I, figs 3, 3*a*), and its avicularia by MacGillivray (1881, PZV, VI, Pl. LIX, fig. 3) and by Levinsen himself (Pl. IV, figs 5*c*—*e*).

In addition to *B. grandis*, the following species may be referred to *Cornucopina*: —

Bicellaria tuba Busk, 1852, VR, p. 373. Bass Straits, 45 fath.; — 1852, BMC, p. 42.
Bicellaria pectogemma Goldstein, 1882, PRSV, XVIII, p. 42. Marion Is, 150—310 fath.
Bicellaria bella Busk, 1884, Chall., p. 34. E. of Celebes, 825 fath.
Bicellaria infundibulata Busk, 1884, p. 33. S. Indian Ocean, 1600—1975 fath.
Bicellaria moluccensis Busk, 1884, p. 34. E. of Celebes, 825 fath.
Syn. *Bicellaria macilenta* Busk, 1884, p. 35. E. of Celebes, 825 fath.
Bicellaria navicularis Busk, 1884, p. 32. Brazil, Tristan da Cunha, 32—2200 fath. (figured specimen from 32—400 fath.).
Bicellaria dubitata Calvet, 1909, Exp. Antarct. Franç. 1903—1905, Bryozoaires, p. 5. Bay of Biscay, 110 M.
Bicellaria polymorpha Kluge, 1914, BDSE, p. 638. Antarctic, 385 M.
Bicellaria lata Kluge, 1914, p. 639. Antarctic, 370—385 M.
Bicellaria rotundata Kluge, 1914, p. 640. Antarctic, 3397—3423 M.
Bicellaria angulata Kluge, p. 641, Antarctic, 2450 M.

The majority of the species are from deep water. Each of three of Kluge's species seems to be definitely related to one of the Siboga species.

The zooecium in most cases has one or more distal spines, and a single spine near the proximal end of the expanded portion, all arising from the basal surface. It has an oblique joint, near its proximal end, dividing off a short proximal section (Pl. XXIX, fig. 2) by which it joins its predecessor. This first section appears to be connected with the expanded part of its predecessor by a communication-plate, as figured by LEVINSEN (Pl. IV, figs 5 *a*, *b*), and its proximal end is acutely pointed, lying close to the lateral rosette-plate which connects two zooecia of opposite sides (figs 6, 15, *l.r.p.*). The second section (fig. 15, *2*) is at first a long, narrow continuation of the first section, then expanding into a wide, turbinate portion, directed obliquely outwards, and forming the major part of the zooecium.

The avicularia, which may be basal or frontal, have a wide range of shape, even in the same colony, although definite forms seem to be characteristic of each species. Among these forms, an elongate type (fig. 7), with a very long, cylindrical stalk, expanding distally, is one of the most remarkable kinds of avicularia found in Cheilostomata.

Most of the features indicated by LEVINSEN will be understood from the descriptions given below; but his views as to the ovicells need attention. His statement that the ovicells are surrounded by kenozooecia (p. 109) must be read in connexion with his Pl. IV, figs 4 *b*, *c* (*C. infundibulata*) and perhaps with the figure of GOLDSTEIN (fig. 3 *a*), to which he does not refer. It is difficult to follow completely his descriptions (pp. 49—67) of the ovicells of Cheilostomata, and to understand how far he considered the various types homologous structures. On pp. 56—60 he described "Endozooecial ooecia", which he recognised in *Cornucopina* (p. 60, *Bicellaria infundibulata*). On pp. 60—65 he gave an account of the "Hyperstomial ooecia" of certain Bicellariellidae, including *Bugula* (p. 60, Pl. XXIV, fig. 13). It appears to me that there are strong a priori reasons for believing the ovicells of *Cornucopina* to be strictly homologous with those of *Bugula*.

The structure of the ovicell of *C. geniculata* is shown in fig. 6, a basal view. The ovicell is a lofty, globose structure, its calcareous wall formed of the ectooecium (*ect.*) and the entooecium (*ent.*), the latter the thicker; and it is attached to the inner part of the distal margin of the zooecium. The space between the two layers, on the outer side of the ovicell, is continued transversely inwards, between the lines *t.w.* and $t\,w^1$. at the base of the ovicell, then expanding into a wider space (*w.*), which gives off a distal branch bordered by two calcareous thickenings (*c.t.*) lying between the two layers of the ovicell, and probably serving to strengthen the attachment of the whole structure. The wide space is continued proximally into a tube, which runs along the median and basal wall of the zooecium to open into the first section (1) of the next succeeding zooecium. In the majority of Cheilostomes, the ovicell is formed in relation with the terminal wall common to the fertile zooecium and its successor, and is completed by a contribution from that successor. In *Cornucopina* the zooecium is thrown outwards at its distal end, the orifice thus lying far on the outer side of the apparent junction between the two zooecia. The terminal wall (*t.w.*) separating the fertile zooecium from its successor is not merely the septum between the two sections of the zooecium, but it extends along the whole of the free median border of the fertile zooecium, and along that part of the distal border which corresponds with the base of the ovicell. The cavity of the proximal section of the second zooecium is similarly prolonged as far as the outer edge of the base of the greatly displaced ovicell, in order to allow it to take its proper share in the development of that structure. In fig. 6, *t.w.* is thus

the terminal wall between the two zooecia, and $t.w^1$. is its frontal edge, continuous with the commencement of the entooecium. The bridge formed by the base of the outer of the two calcareous thickenings (*c.t.*) is continuous with the ectooecium, so that it does not interrupt the continuity of the cavity *w.* with the space between the two layers of the ovicell, on the outer side. The ovicell is thus of the typical hyperstomial type found in other Bicellariellidae, arising by a broad base from a specially modified part of the terminal wall between the ovicell and its longitudinal successor. LEVINSEN's figures (Pl. IV, figs 4 *b*, *c*) show a part of the tube (*t.*) above described, but the structure appears to be incomplete in *C. infundibulata*. The complete tube is shown, in *C. grandis*, by GOLDSTEIN (l. c.), who does not, however, offer any explanation of the arrangement.

The method of bifurcation in *Cornucopina* is described under *C. geniculata* (fig. 5).

Key to the Siboga species of *Cornucopina*.

1	Zooecium with a digitiform process bearing long spines	2.	
	Zooecium without a digitiform process, its expanded part free, conical	4.	*C. conica.*
2	Spines of the digitiform process typically restricted to its outer end. Basal avicularia, if present, extremely long.	1.	*C. moluccensis.*
	Spines of the digitiform process borne by its distal border as well as terminally. Avicularia not longer than the opesia.	3.	
3	Avicularia strongly bent at the distal end of the stalk	2.	*C. geniculata.*
	Avicularia not strongly bent	3.	*C. bella.*

1. *Cornucopina moluccensis* (Busk). (Pl. XXIX, figs 7—10, 13—16).

Bicellaria moluccensis Busk, 1884, Chall., p. 34, Pl. VI, fig. 4. E. of Celebes, 825 fath.
Bicellaria macilenta Busk, ibid., p. 35, Pl. XXXII, figs 1 *a—d.* Same locality and depth.

464. A. Stat. 90. E. Borneo, 281 M. Fragment.
499. B. Stat. 161. W. of N. end of New Guinea, 798 M.
604. A. Stat. 177. N. of Ceram, 1300—1633 M.
526. H. Stat. 211. S. of Celebes, 1158 M.
641. A. Stat. 227. Banda Sea, S. of W. end of Ceram, 2081 M. Fragment.
636. A. Stat. 241. Off Banda, Banda Sea, 1570 M.
628. D. Stat. 295. S. of W. Timor, 2050 M.

Zooecia narrow and cylindrical proximally, wide and regularly turbinate distally, sometimes wide and cylindrical on the proximal side of the opesia; produced externally and distally into a long digitiform process bearing a group of terminal, elongate, curved spines. These are usually 5, but may be 6 or 2—4. A similar spine is occasionally developed from near the middle of the distal border of the process. The basal side of the zooecium has two distal spines and another on the inner side of the avicularian base, near the level of the proximal end of the opesia. Opesia oblique, not very long, wider distally, where its outer corner extends to the base of the digitiform process, rarely to its end. Basal avicularia elongate, borne by a low tubercle, just outside the proximal spine; variable in size and form, the commonest kind very long, compressed, with the palatal surface terminal and nearly at right angles to the main

axis. A small frontal avicularium occasionally present at the base of the expanded part of the zooecium. Ovicells (figs 13, 16) longer than wide, the small calcareous strengthening bars of the basal surface close to the inner border.

The expanded part of the zooecium is often regularly turbinate (fig. 13), but in 604. A (fig. 15) and others the narrow proximal part is succeeded by an elongate cylindrical portion, to which the opesia does not extend. Rootlets are found on parts of the colony far from its origin, and are commonly produced by the axillary zooecium, basally and near the distal end; but may be given off by other zooecia as well. When formed by an axillary zooecium, they usually pass proximally, closely applied to the basal side of the branch, which they help to strengthen. The rootlet is sometimes reversed in direction and may then give rise to a uniserial stem, which soon becomes biserial. The narrow proximal ends of the zooecia are readily separable, and may perhaps be normally separate in some of the bifurcations.

The avicularia, which are readily lost, are highly variable. They are best seen in 499. B, where the same colony bears avicularia of several kinds. The commonest (fig. 7) has an exceptionally long, cylindrical proximal part, usually commencing in a short dilatation (fig. 8) on the distal side of its narrow base. The avicularium expands distally, where it is much compressed, the palatal surface being thus narrow and placed nearly at right angles to the long axis. The occlusor muscle has a short base and runs into a tendon, which is inserted into the mandible just distally to the union of the two converging halves of the main sclerite (fig. 7). A group of muscle-fibres, inserted into the frontal membrane, no doubt acts as a divaricator. The polypide-rudiment (*p.*) is distinct, as in the second type of avicularia, and in both kinds the mandible ends in a conspicuous spike, in opposition to Busk's statement. The avicularia of the first type vary much in size, some being gigantic and others much smaller. They are produced by a considerable number of the zooecia, but not by all, since the avicularian tubercle and the associated spine may be wanting. The second type of avicularium (fig. 9) differs from the first in having its palatal surface oblique, the occlusor muscles originating from a much longer part of the avicularium than in the first type; an arrangement doubtless due to the fact that the obliquity of the palate allows the occlusor to have a longer effective origin from the opposite side. Avicularia of the two types may occur on adjacent zooecia, and are small (fig. 13) or gigantic (fig. 9), as in one preparation where two such avicularia occur. The fragment 464. A has several avicularian tubercles, but only one avicularium (fig. 14). The base is curved, but I regard it as a modification of the second type; the zooecial characters agreeing with those of the other specimens. In *C. infundibulata*, Busk described avicularia resembling that just mentioned, associated with elongate tubular avicularia (1884, Pl. VI, figs 2 *b*, *d*). 526. H and 628. D are basal fragments, in poor condition and without avicularia.

The digitiform process of *C. moluccensis* may be present or absent on the axillary zooecium and is sometimes wanting on one or two of the neighbours of that zooecium on the inner sides of the branches. The ovicell (fig. 16) differs from that of *C. geniculata* (fig. 6) in the position of the two calcareous thickenings (*c. t.*). The fertile zooecium has an ovary, situated as in *C. geniculata* (fig. 6, *ov.*), at the proximal end of the inner border of the expanded portion of the zooecium. The ovary, which has several eggs, is at first very small; but an egg ready to pass into the ovicell is large and full of yolk. I have not found testes in the fertile zooecia,

but they often occur in adjacent zooecia, along the inner wall of most of the narrow proximal part of the second section of the zooecium.

604. A (figs 8, 10, 15) has the commencement of the free part of the zooecium long and cylindrical (as in *C. macilenta*), the opesia extends to the distal end of the digitiform process, and small frontal avicularia (not found in other specimens) occur at the proximal end of the free part of the zooecium, as well as typical elongate avicularia. The distinction between the extreme variations seems to be generally bridged over, however, by specimens of intermediate character; and I regard *C. moluccensis* as a species varying in the form of the zooecia, in the extension of the opesia on the digitiform process, in the presence or absence of small frontal avicularia and in the form and size of the elongate avicularia. I think that *C. macilenta* (Busk), described as without avicularia, is probably a form *C. moluccensis*, with which it was found.

The tentacles (636. A) are 16.

C. angulata (Kluge, 1914, p. 641, text-fig. 23) is nearly allied to *C. moluccensis*, which it resembles in the digitiform process and its spines. The opesia is relatively larger than in *C. moluccensis*, and is prolonged inwards almost as far as the joint of the next zooecium in its own row; and a considerable proximal cryptocyst appears to be present. The avicularia are short and are not unlike those shown in fig. 10. Ovicells were not described.

2. *Cornucopina geniculata* n. sp. (Pl. XXIX, figs 4—6).

531. A. Stat. 122. N. of Menado, N. Celebes, 1165—1264 M. One colony.

Zoarium reaching a height of not less than 40 mm., of the same general habit as *C. moluccensis*, the stalk constituted mainly of rootlets. Zooecia rather larger than in that species, the narrow proximal end of the second section angulated externally opposite the rosette-plate; the expanded portion with a cylindrical proximal part of varying length, or regularly turbinate. Opesia longer than wide, narrow proximally, widest distally. Digitiform process well developed (occasionally wanting), usually with 5 spines. These are not confined to a terminal group, but extend along the distal border of the process, often passing nearly continuously into a series of 3—5 spines in a transverse row across the distal end of the zooecium, basally. This continuity is interrupted in cases where the spines of the digitiform process are restricted to its outer half. Proximal basal spine wanting. Axillary zooecium (fig. 5, E) with no digitiform process, bearing 1—2 distal spines basally, its frontal membrane very oblique, directed towards the branch corresponding with the zooecium A. Avicularia on many of the zooecia, arising from an elongate, oval, frontal area, just internally to the proximal end of the opesia; the proximal portion very short, abruptly geniculate (hence the trivial name) at the end, where the avicularium becomes robust and takes the form of a compressed cylinder (fig. 4). Palatal surface terminal, the rostrum and mandible essentially as in *C. moluccensis*. Ovicells as in that species, but with the two supporting calcareous thickenings (fig. 6, *c.t.*) near the middle of the basal surface.

C. geniculata differs from the other Siboga species in the position and shape of the avicularia, in the characters of the axillary zooecia and in the absence of the proximal basal spine. The structure of the ovicell has been described above, under the genus.

The mode of bifurcation occurring in this species is typical of the genus. Where no

bifurcation is taking place the acute proximal end of the first section of a zooecium begins at the conspicuous lateral rosette-plate (Fig. 5, *l.r.p.*). Bifurcation is inaugurated by a doubling of the zooecia on the distal side of A and B, although F, like G, may be derived from E. The inner zooecium thus formed, in each case, commences at the rosette-plate, while the outer daughter-zooecium is given off, slightly more distally, from a process of the parent-zooecium. The axillary zooecium (E) has an expanded part which projects into the interval between the two branches, and it has no digitiform process.

A young ovary (*ov.*) is shown near the lateral rosette-plate of a fertile zooecium, in fig. 6. This zooecium contains a functional polypide and two brown bodies (*b.b.*). Testes (fig. 5, *tes.*) are found in some of the adjacent zooecia, in both sections of the body-cavity.

C. geniculata is closely allied to *C. rotundata* (Kluge) (1914, p. 640, Pl. XXXIII, fig. 2), which has a regularly oval opesia, slightly narrower distally, with a spine near its proximal end. The digitiform processes and the avicularia of the two species are similar, but the terminal cylindrical part of the avicularium is considerably shorter and relatively wider in *C. rotundata*; Kluge describing it as resembling a tobacco-pipe. The angle between the proximal part and its head is larger than in *C. geniculata*, and Kluge's species has less angulated, short avicularia on the outer sides of the zooecia. Ovicells were not found.

3. *Cornucopina bella* (Busk) (Pl. XXIX, fig. 11, 12).

Bicellaria bella Busk, 1884, Chall., pp. 34, 36, Pl. VI, figs 3—3*b*. E. of Celebes, 825 fath.

534. A. Stat. 226. Off Lucipara Id, Banda Sea, 1595 M.
200. B. Stat. 280. E. of Timor, 1224 M.

Zoarium as in *C. moluccensis*. Zooecia angulated opposite the lateral rosette-plates, as in *C. geniculata*; the expanded part with a longer or shorter cylindrical portion, widening in the region of the opesia, which is elongate or short, narrower proximally. Digitiform process well developed, rarely wanting, bearing 4—8 (commonly 6) long spines, spaced out along its distal border, the series generally continuous with about 6—7 similar spines in a curved row on the basal surface of the zooecium. The continuity may be interrupted, the spines then occurring in two groups, one near the free end of the process and the other on the zooecium. Axillary zooecium projecting freely for the length of its opesia, which is oblique as in *C. geniculata*; with a digitiform process bearing 2 spines and a reduced number of basal spines, or without this process. Avicularium (fig. 12) usually present near the middle line, on the proximal side of the opesia, small, moderately elongate, the proximal part straight or gently curved. A second avicularium may be present, near the first, and occasionally a third, on the free end of the digitiform process. Palatal surface of avicularium terminal. Ovicells longer than broad, depressed; the two basal calcareous thickenings rather widely separated, the inner one starting at or close to the inner border of the ovicell, and the outer one at its middle.

The Siboga material was obtained from practically the same locality as Busk's type-specimens. *C. bella* seems to be allied to *C. navicularis* (Busk) from the Atlantic, and to *C. geniculata*, from which it differs in having straight avicularia. I cannot convince myself that these are articulated at the base.

The occurrence of two or even three avicularia on a single zooecium (the lowest in fig. 11) is exceptional and was noted by Busk. There are only three fertile zooecia in my material, but they seem to indicate that these are the individuals in which three avicularia occur. In one instance I have found a second avicularium on the end of the digitiform process in an ordinary zooecium. The ovicell of *C. bella* differs from that of *C. geniculata* in its proportions and in the situation of the basal calcareous thickenings.

While 200. B has an elongate opesia and the arrangement of spines shown in fig. 11, 534. A differs from it in both respects; but the characters of the avicularia are identical in the two specimens. The opesia of 534. A is short, the series of spines is interrupted by a space, and the axillary zooecium has no digitiform process. The complete armature of spines is perhaps developed only in vigorous zooecia, and is reduced in others. The most internal basal spine of *C. bella* probably corresponds with the single spine of certain other species, in which it has become isolated by the suppression of others of the series.

The rootlets are robust, with well calcified walls and an occasional chitinous joint, not in line with those of other rootlets in the same bundle.

4. *Cornucopina conica* n. sp. (Pl. XXIX. figs 1—3).

Type. 146.A. Stat. 170. Between New Guinea and Ceram, 924 M.
526.D. Stat. 211. S. of Celebes, 1158 M.

Cambridge, Mus. Zool.: —

BM Challenger, Stat. 147, off Crozet Is, S. Indian Ocean, 1600 fath. (as *Bicellaria infundibulata*). Presented by the British Museum, Reg. Nov. 18, 1899.

Zoarium as in *C. moluccensis*, reaching a length of at least 43 mm. Zooecia without a digitiform process, the expanded part regularly conical, elongate, narrow at the origin of the free portion, much widened distally. Opesia short, broader than long, obscurely pointed proximally, the operculum asymmetrically placed near the distal inner border. A transverse row of long spines on the basal surface, distally, and a basal spine at the origin of the free portion. Avicularia arising from a small basal tubercle, on the median side of the distal spines and continuing their line of origin; the proximal part extremely long, cylindrical, dilating distally; the palatal surface subterminal, more or less oblique. Ovicell very shallow, much broader than long, the tube which, in other species, connects its base with the first section of the succeeding zooecium incomplete and ending blindly.

The avicularia (fig. 1) resemble that type in *C. moluccensis* which has a terminal biting surface, which is more oblique, however, than in that species, and in one or two instances is more longitudinal than in the figured specimen. The avicularia are readily lost, but in such cases the tubercle (fig. 2, *av.t.*) with which they articulate can often be found. There are about 16 tentacles.

The zoarium is but slightly calcified, and is extremely delicate and fragile. Although differing greatly in the form of its zooecia from most of the other species, *C. conica* agrees with them in its zoarial characters, in its mode of bifurcating, in the constitution of the proximal ends of its zooecia, in the general arrangement of its spines and in the form of its avicularia,

which closely resemble those of *C. moluccensis* and other species. Its most striking peculiarity is the ovicell (fig. 3), which is remarkably short and even vestigial. It is produced by an ordinary zooecium, and the tube (*t.*) which in *C. geniculata* connects its base with the succeeding zooecium is incomplete and blind, but runs a short way proximally. The same arrangement of the tube is found in *C. infundibulata*, as shown by LEVINSEN (1909, MSSB, Pl. IV, figs 4 *b*, *c*).

C. infundibulata was described by BUSK (1884, Chall. p. 33, Pl. VI, figs 2 *a*—*d*) from specimens obtained by the Challenger at Stat. 147, in the S. Indian Ocean, and his account is supported by the type-material in the British Museum. The zooecia differ from those of *C. conica* in not becoming free from the axis except at their outer distal ends. The avicularia are mostly of the kind with short stalks figured by BUSK. Ovicells of a remarkable type were briefly described, but not figured and may be seen in profusion on BUSK's type-slide 87. 12. 9. 159. They were later figured, probably from Challenger material, by LEVINSEN (Pl. IV, figs 4 *a*—*d*). The ovicell is not vestigial and is developed, as stated by BUSK, on a "special zooecium" which arises, by a very narrow stalk, from the basal and distal end of an ordinary zooecium. The gonozooecium is rather smaller than the ordinary zooecia, it possesses no spines, and it is completely free, as represented by LEVINSEN.

Among the Challenger specimens determined as *Bicellaria infundibulata*, from Stat. 147, was one which was presented by the British Museum to the Cambridge Museum in 1899. There is no evidence that it had been specially examined by BUSK and it proves to belong to *C. conica*. Its zooecia are free for the whole extent of their turbinate portion, the avicularia are greatly elongated, and a vestigial ovicell occurs, as in the Siboga material (fig. 3).

C. polymorpha (Kluge) (1914, p. 638, Pl. XXX, fig. 1) is intermediate between *C. infundibulata* and *C. conica*, the ovicell being developed on a "special zooecium" as in the former, but being vestigial, as in the latter. The gonozooecium is much bent and resembles a tobacco-pipe. The egg of *C. polymorpha* develops in the body-cavity of the zooecium, in correlation with the reduction of the ovicell, as shown by KLUGE. The zooecia resemble those of *C. infundibulata* in being for the most part adnate to the axis. Elongate basal avicularia occur, as in the other two species under consideration, in addition to small frontal avicularia at the proximal end of the opesia. *C. infundibulata* also has small avicularia, but they occur at the distal end of the opesia. It may be remarked that KLUGE's figure is a composite one, based on several specimens.

4. **Calyptozoum** [1]) n. gen.

Zoarium commencing with a stalk composed of parallel rootlets, diverging at their base into a tuft for attachment. Branches biserial, the zooecia alternate and extremely elongate, the proximal portion long and narrowly tubular, the distal portion expanded and shorter. Opesia terminal, subcircular, depressed, forming a cup, to which an avicularium, jointed at its base, serves as a lid. Rostrum and mandible of avicularium acute. Ovicell globose, the aperture closed by the avicularium.

1) *καλυπτός*, covered, in reference to the covering of the opesia by the avicularium.

Genotype, *C operculatum* n. sp.

The genotype of *Calyptozoum* is one of the most remarkable species dredged by the Siboga. I owe the opportunity of examining it to the kindness of Prof. BILLARD, the specimens having been sent to him as Hydroids, which they resemble in general appearance.

1. *Calyptozoum operculatum* n. sp. (Pl. XXVII, figs 5—10).

Type. 634.A., 650.A. Stat. 211. S. of Celebes, 1158 M. Coarse grey mud.

Zoarium reaching a length of at least 20 mm., the stalk about 10 mm. long, traversed by one or two oblique joints, at which each rootlet is dilated. Axillary zooecium extending far beyond the axil. Zooecia diverging obliquely outwards and distally from the commencement of their free portion, and here very regularly cylindrical; composed of two sections, separated by a joint, the proximal section not forked and extremely short. Opesia surrounded by a thickened calcareous ring, situated at the distal end of the free portion of the zooecium. A single variably branched spine originating on the frontal side of this ring, and an unbranched spine opposite to it, on the basal side. An avicularium, articulated to the outer border of the calcareous ring, capable of being folded over the cupped end of the zooecium so as to form a functional operculum or lid (hence the trivial name). Gonozooecia similar to the ordinary zooecia, but with a wider free portion. Ovicells two-layered, very globose, recumbent on the axis of the branch and slightly overlapping it on the basal side. Avicularia of the gonozooecia larger than the others, with a lateral flange on each side, acting as a lid to the ovicell.

The modification of the avicularia as lids of the cup-shaped ends of the zooecia, those of the gonozooecia closing the ovicells as well, is a very striking feature, which is not known to occur in any other Polyzoa. In the majority of cases (figs 5, 9), they are thus folded down, but in one or two zooecia (fig. 6) they stand erect at the edge of the cup. In both kinds of zooecia, muscles (fig. 7, *m.*) are found at the outer distal end; and, although I have not been able to trace their insertion, their direction is such as to make it probable that they are flexors of the avicularia, which are of the *Bugula* type. The affinities of the genus are specially with *Cornucopina*, as shown by the general conformation of its parts, and more particularly by the zooecia composed of two sections, the proximal one very short, and by the resemblance of its lateral rosette-plates, in position and form, to those of that genus. The rosette-plates are conspicuous lens-shaped bodies, one of which projects from near the proximal end of each zooecium into the body-cavity of its lateral neighbour. Similar rosette-plates occur on the outer wall (fig. 5, zooecia A, C) and may give rise to rootlets (*r.*).

The frontal membrane is deeply depressed, within the cupped end. I have not found an operculum; but, in view of the efficient protection given by the avicularium, it seems probable that, as in *Bugula*, it is hardly differentiated from the rest of the frontal membrane. The frontal marginal spine may be bifid, trifid, or even more branched; and it is broadest and most branched in the gonozooecia (fig. 7). The avicularium is here modified by the production of a lateral flange on each side. That of the basal surface (figs 7, 10 *fl.*) is the more developed, and forms the principal part of the lid of the ovicell. The ovary (fig. 7, *ov.*) is developed on the inner wall, and a very large egg (fig. 10, *e.*) may occur in the body-cavity, before it reaches

the ovicell. Testicular tissue (fig. 7, *t.*) seems to be found in the proximal parts of some of the ordinary zooecia.

The bifurcation, shown in fig. 5, agrees nearly with that of *Cornucopina*, but the axillary zooecium (E) extends even further beyond the axil than in that genus, and only one zooecium is formed at the distal end of B.

The stem of 650. A (fig. 8) shows a remarkable jointing arrangement, which occurs twice. The joints are extremely oblique and are associated with a dilatation of each of the rootlets at the joint. The stalk has broken at the distal joint in the figured specimen. The rootlets of the basal tuft bifurcate several times.

2. *Calyptozoum campanulatum* n. sp. (Pl. XXVII, figs 11, 12; text-fig. 22).

153. C. Stat. 211. S. of Celebes, 1158 M. Coarse grey mud.

Zoarium as in *C. operculatum*, from which *C. campanulatum* differs in the following respects. — The free parts of the zooecia are conical or bell-shaped and communicate with the proximal parts by a small aperture, owing to the development of a strong calcareous ring, thickest distally and dying away proximally at the end of the expanded portion, which is not jointed at its proximal end. Ovicells and avicularia have not been found.

This species is unfortunately poorly represented, the single colony (text-fig. 22), 35 mm. long, being very incomplete. Only one zooecium (fig. 11) is even approximately complete; the expanded portions of all the others being merely their commencements, while even these are wanting in the majority of cases, as in the zooecium A. Although avicularia have not been found, the zooecium E has a group of muscle-fibres (*m.*) in the same position as that of the supposed avicularian flexor of *C. operculatum*. The occurrence of an avicularium, as in that species, can thus be confidently assumed. The zooecium E bears a small semicircular ring (seen to the left of the figure) provided with minute teeth at its margin. This is perhaps the broken base of the avicularium.

Fig. 22. — *Calyptozoum campanulatum.* Zoarium (153. C), natural size.

The specimen may be referred to *Calyptozoum* in view of the form and arrangement of the zooecia; the characteristic rosette-plates, including some external ones giving rise to rootlets; the mode of bifurcation; and the constitution of the stalk, particularly its peculiar jointing (fig. 12). This last resemblance is so detailed that, taken with the other points of similarity, the assignment of the species to *Calyptozoum* is fully justified.

Although the specimen is from the same Station as those of *C. operculatum*, the shape of the distal ends of the zooecia, the constricted communication of these with the proximal parts, and the absence of proximal joints in the zooecia appear to negative the supposition that this is merely a form of the other species. Rootlets are developed much more plentifully than in *C. operculatum*, occurring even on zooecia at the distal ends of the branches. Those of the basal tuft are several times bifurcated. A conspicuous dilatation of one of the rootlets occurs in the course of the stalk and resembles that found in *Euoplozoum cirratum* (Pl. XXX, fig. 1). It is found at the point where the rootlets begin to diverge to form the basal tuft, but it is so distant from the lowest zooecia that its origin is not ascertainable. A similar dilatation is seen

in one of the specimens (634. A) of *C. operculatum*, but rather higher up the stalk. In this case it seems probable that, as in *Euoplozoum*, it is given off by the lowest zooecium, which is presumably the ancestrula.

5. **Bugula** Oken.

Bugula (pars) Oken, 1815, LN, p. 89; et auctt.
Acamarchis Lamouroux, 1816, PCF, p. 132.
Halophila Gray, 1843, DNZ, p. 292.
Avicularia Gray, 1848, BMRA, pp. 105, 146.
Bugulina Gray, 1848, BMRA, p. 114.
Crisularia Gray, 1848, BMRA, pp. 111, 147.
Flabellaria (pars) Gray, 1848, BMRA, pp. 106, 146.
Avicella Van Beneden, 1848, BARB, XV (1), p. 74.
Ornithopora D'Orbigny, 1852, ASNZ, 3, XVI, p. 312; — 1852, PFTC, pp. 320, 321.
Ornithoporina D'Orbigny, 1852, ASNZ, 3, XVI, p. 312 (*Ornithoorina*, errorim), 313; — 1852, PFTC, pp. 320, 322.
Dendrobeania Levinsen, 1909, MSSB, pp. 99, 113.

Genotype, *Sertularia neritina* Linn., 1758, SN, p. 815. See HINCKS 1880, BMP, p. 75 and HARMER, 1923, JLS, XXXV, p. 299; see also pp. 297—314 of the same paper for the other genera mentioned in the synonymy.

Zoarium unilaminar, biserial to pluriserial. Zooecia alternate, boat-shaped, the basal and lateral walls calcified, the frontal surface mainly occupied by the elongate opesia, covered by the frontal membrane, in which an operculum differing in texture from the rest of the membrane is rarely discernible. One or more distal spines usually present. Proximal end of the zooecium forked and equitant basally on the distal end of its predecessor. Avicularia resembling birds' heads on the frontal or lateral surfaces of the zooecia; rarely wanting. Ovicells hyperstomial, typically globose, frequently with a very narrow peduncle, on the distal margins of the fertile zooecia.

In the above diagnosis I have excluded the species placed by BUSK (1884, Chall., p. 37) in his Sections α and β of the genus; and for these I have previously proposed the names *Himantozoum* and *Camptoplites* respectively (see pp. 453 and 452).

In an earlier paper (1923, JLS, XXXV, pp. 320—328) I maintained that the study of the bifurcations is of value in taxonomy. This conclusion can be applied with special advantage to *Bugula*, many of the species of which are not easy to define unless this character is taken into account. A parallel series of modifications may occur in other genera, as in *Caulibugula*, the species of which belong respectively to my Types 5, 4 and 2. This fact seems to indicate that the type of bifurcation cannot in itself be taken as deciding affinities, at any rate between two species of different genera. It seems to show that differences in the extent of splitting of the unilaminar sheet have produced the same results in more than one genus.

It is here necessary to consider three only of the methods of bifurcation previously distinguished; namely those which I designated Types 3—5. I arrange the Siboga species of *Bugula* according to the type with which they respectively agree. The three types in question are illustrated by text-fig. 23, constructed from camera lucida drawings of three selected species.

I have adopted the same notation of the zooecia throughout this Report. A is the most proximal zooecium, preceding a bifurcation, which gives rise to two distal successors, designated respectively as C and E. Of these, E is related to the axil of the bifurcation, and is often more or less median, with characters somewhat different from those of other zooecia; B is that zooecium, of the other side of the branch, which at its proximal end is in lateral contact with A, its distal end extending beyond the corresponding part of A. E gives rise to F and G, the first inner zooecia of the two branches formed by the bifurcation; F being on the inner side of D, and G being on the inner side of C. In Type 5 it is necessary to consider also the zooecium H, the distal successor of F. The proximal zooecia of the inner sides of the two branches are united by a connecting process (*c. p.*).

Type 5 (text-fig. 23, A). — The axillary zooecium (E) is almost or quite completely immersed in the parent internode; the split which divides the two branches only reaching its

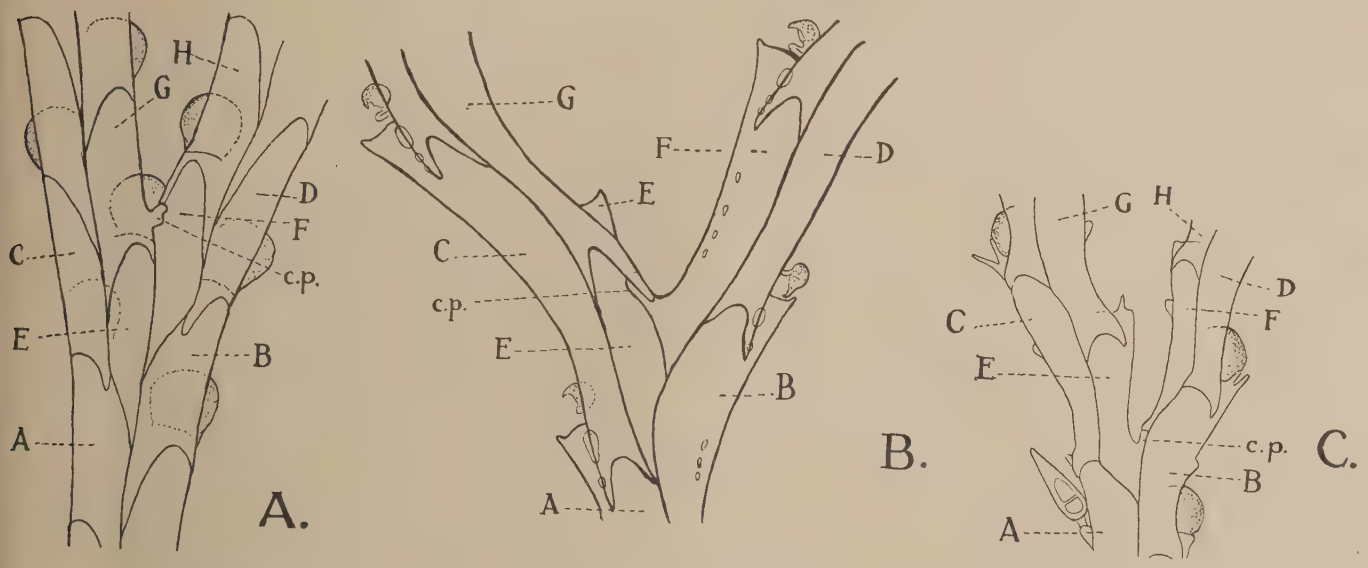

Fig. 23. — Camera lucida drawings of bifurcations, seen from the basal side. A, Type 5, *Bugula philippsae* (41. A[1]). B, Type 4, *B. scaphoides* (138. A[1]). C, Type 3, *B. cucullata* (541. E[1]). Obj. A, reduced 3/4. For explanation see text.

distal end. The connecting process is given off by G, and joins the inner lobe of the forked proximal end of H. This type of bifurcation occurs also in *Caulibugula*; *e. g.*, in *C. exilis*.

Type 4 (text-fig. 23, B). — Part of the axillary zooecium (E), but not more than its distal half, is exposed in the axil; the split which divides the branches extending further proximally than in Type 5. The connecting process is given off by F and joins the inner half of the forked end of G, this part crossing the basal surface of E, near its distal end, in an oblique direction. This type of bifurcation occurs also in most of the species of *Caulibugula*.

Type 3 (text-fig. 23, C). — The greater part of the axillary zooecium (E) is exposed in the axil; the split which divides the branches extending nearly to its proximal end. The connecting process is given off by E and joins the proximal end of F. In this type, each of the pairs EC and DF has a common proximal fork, one half of which belongs to each of the members of the pair.

Key to the Siboga species of *Bugula* [1]).

1	Avicularia present.		2
	Avicularia wanting (*Halophila* auctt.)		10
2	Bifurcation of Type 5 (text-fig. 23, A)		3
	Bifurcation of Type 4 (text-fig. 23, B)		6
	Bifurcation of Type 3 (text-fig. 23, C)		8
3	Opesia in the frontal plane of the branch. Distal spines represented by a single external point. Avicularia large, the rostrum usually with two lateral triangular cusps	1. *B. robusta.*	
	Opesia inclined towards the middle line of the branch, its external border more or less inrolled. Distal spines present on both sides. Avicularia without cusps.		4
4	Zoarium with an elongate stalk, composed of kenozooecia, followed by turbinate zooecia with a number of spines. Distal spines 3, 2. Ovicells projecting beyond the external margin of the branch	2. *B. philippsae.*	
	Zoarium without a long stalk.		5
5	Distal spines 3, 1, generally long and jointed. Avicularia of two kinds. Ovicells not projecting beyond the external margin of the branch.	3. *B. dentata.*	
	Distal spines 3—1, 2—1, small, unjointed. Avicularia of one kind, on the distal half of the zooecium. Ovicells?	4. *B. pedata* [2]).	
6	Zooecia narrow, of nearly uniform width, their frontal planes sloping basally from the middle line of the branch. Proximal zooecia with longitudinal thickening bars in the external wall.	5. *B. vectifera.*	
	Zooecia wider distally. Proximal zooecia without thickening bars		7
7	Avicularia compressed. Ovicells with a conspicuous hexagonal sculpturing on the entooecium	6. *B. scaphoides.*	
	Avicularia broad, subglobose. Ovicell with a thickening band round the aperture and no entooecial sculpture	7. *B. subglobosa.*	
8	Branches conspicuously jointed proximally.	8. *B. mollis.*	
	Branches not jointed proximally		9
9	External margin of zooecium inrolled, bearing a spine. Avicularia on the distal half of the zooecia, of two kinds	9. *B. dispar.*	
	External margin not inrolled. Avicularia on the proximal half or near the middle of the length of the zooecia, of one kind. Distal spines 2, 1	10. *B. cucullata.*	
10	Length of the opesia less than twice its width. Inner limb of forked proximal end of zooecium reaching the second preceding alternate zooecium	11. *B. johnstonae.*	
	Length of the opesia generally more than twice its width. Inner limb of forked end of zooecium not nearly reaching the second preceding alternate zooecium.	12. *B. longicauda.*	

1) In stating the numbers of distal spines, those on the outer side are given first.
2) The more proximal bifurcations of *B. pedata* are of Type 4.

(*a*) Bifurcation of type 5.

1. *Bugula robusta* MacGill. (Pl. XXXII, figs 1—7).

Bugula robusta MacGillivray, 1869, PRSV, IX, p. 129. Victoria; — 1883, PZV, VIII, p. 29, Pl. LXXVIII, figs 1—1*b*.
Bugula neritina Waters, 1887, AMNH, 5, XX, p. 91, Pl. IV, figs 3, 15. Port Jackson.
Bugula neritina Thornely, 1905, PGM, p. 109. Ceylon; — 1907, MPIM, p. 183. Burma; — 1912, PIOS, p. 141. Amirante and Cargados Is (Indian Ocean).
Bugula neritina, var. *rubra* Thornely, 1912, PIOS, p. 141, Pl. VIII, fig. 1. Amirante and Providence Is (Indian Ocean).
Bugula neritina, var. *tenuata* Thornely, 1912, p. 142, Pl. VIII, fig. 2. Cargados Is (Indian Ocean).
Bugula neritina, var. *minima* Waters, 1909, SRS, p. 136, Pl. XI, figs 4—7. Sudanese Red Sea; — 1913, BEA, p. 471. Zanzibar.
Bugula neritina, forma *minima* Marcus, 1921, IPBS, p. 1, Pl. I, fig. 1. Gaspar Strait.

286. B. Stat. 33. Pidjot Bay, Lombok, 0—22 M.
287. A. Stat. 61. Lamakwera, Solor Id, E. of Flores, reef.
616. A. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
37. Y. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
644. A. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
467. E. Stat. 91. Muaras Reef, E. Borneo, 0—54 M.
366. A. Stat. 93. Tawi-Tawi Is, Sulu Archipelago, 12 M.
639. A. Stat. 97. Sulu Archipelago, 564 M.
92. A. Stat. 117. Kwandang Bay, N. Celebes, 80 M.
102. A. Stat. 133. Lirung, Talaut Is, S. of Mindanao, 0—36 M.
489. B. Stat. 136. Ternate, 23 M.
394. H. Stat. 144. S. of Halmaheira (Djilolo), 45 M.
139. C. / 118. A. Stat. 164. W. of N. end of New Guinea, 32 M.
149. B. Stat. 184. Manipa Id, between Ceram and Buru, 36 M.
519. B. Stat. 208. S. of S. E. Celebes, 1886 M.
376. D. Stat. 213. Saleyer, S. of Celebes, 0—36 M.
353. B. Stat. 240. Banda, Banda Sea, 0—45 M.
185. A. Stat. 258. Kei Is, 22 M.
184. B. Stat. 260. Kei Is, 90 M.
299. G. Stat. 273. Jedan, Aru Is, 13 M.
236. A. Stat. 310. Sumbawa, E., 73 M.
255. A. Stat. 311. Sapeh, E. Sumbawa, 0—36 M.
553. A. Stat. 313. Saleh Bay, N. Sumbawa. 0—36 M.
251. C. Stat. 315. Paternoster Is, N. of Sumbawa, 0—36 M.
259. F. Stat. 318. Off Kangeang Id, N. E. of E. end of Java, 88 M.
263. B. Stat. 319. Java Sea, 82 M.
555. B. Stat. 320. Java Sea, 82 M.
416. D. Stat. 321. Java Sea, 82 M.
374. G. Locality not recorded.

Zoarium robust, attached by proximal rootlets. Branches biserial, with conspicuous, zigzag, jointing lines on the basal surface. Zooecia with external distal edges projecting so as to give a serrate outline to the branch, here produced into a sharp angle, the inner distal margin rounded. Opesia widened distally. Basal surface convex, often produced, in the middle line, into a distally directed calcareous spine, which may exceed a zooecium in length. Avicularium large, borne on a cylindrical tubercle, sometimes of considerable length, arising on the outer side, generally near the proximal end of the opesia; its rostrum long, strongly hooked, passing on each side into a triangular cusp, occasionally evanescent or wanting. Ovicells narrowly

pedunculate, on the inner distal border of the zooecium; the aperture surrounded by a circular thickening band.

In 1887 WATERS described a form, which he referred to *B. neritina*, differing from the typical form by the possession of large avicularia, and he has been followed by later writers in referring avicularium-bearing specimens to this widely distributed species. I have had some hesitation in coming to a conclusion with regard to this question; but it must be pointed out that not one of the numerous specimens obtained by the Siboga is destitute of avicularia. On the other hand, the remaining characters of the form under consideration agree closely with *B. neritina*, as may be seen by comparing my figures with BUSK's account (1852, BMC, p. 44, Pl. XLIII, figs 1—6) of that species.

I think the Siboga specimens should be referred to *B. robusta* MacGillivray, a Victorian species resembling *B. neritina* in most respects, but differing from it in possessing avicularia. These structures, in the specimens from the Malay Archipelago, vary in respect of their cusps.

Specimens, in the British Museum and the Cambridge Museum, from Port Jackson, an intermediate locality, help to connect the Malay specimens with *B. robusta*, in which MACGILLIVRAY (1883, fig 1 *a*) just indicates the existence of avicularian cusps. *B. neritina* has probably been derived from an ancestor resembling *B. robusta*, by the loss of the avicularia; and it may be noted that MACGILLIVRAY has recorded it (1881, PZV, VI, p. 41) from Victoria, where it occurs with the other species.

The avicularia of the Siboga specimens are remarkably strong, generally present on nearly every zooecium, but not infrequently wanting on the more proximal members of the colony. They typically possess two strong, triangular, lateral cusps (fig. 7), which are occasionally evanescent, a condition most commonly occurring on some of the paler specimens. A considerable amount of variation is found in the length and curvature of the rostrum, as illustrated by figs 1—3. The length of the peduncle is also variable. It is often short (fig. 5), but it sometimes reaches a length equal to the greatest transverse diameter of the avicularium (fig. 2), and may then overarch the frontal membrane. These specimens seem to agree with *B. neritina*, var. *tenuata* Thornely. Although usually close to the proximal end of the opesia, the peduncle may originate on its external side (fig. 2), at a moderate distance from that end.

The Siboga specimens are of two kinds; — (1) a form of a rich red colour (sometimes pale), the avicularia with strong triangular cusps (fig. 1). In colour and in possessing cusps, this form agrees with Miss THORNELY's *B. neritina* var. *rubra*; (2) a pale form, in which the avicularium is usually long and slender, with vestigial cusps or none at all, and the calcareous processes of the basal side of the zooecia (fig. 4) are extremely long and narrow. In consequence of the variability of the species I cannot regard these two types as separable.

This fine species is the dominant form of *Bugula* in the Siboga area, having been found at no less than 28 Stations, mostly in shallow water, but in two instances (Stations 97, 208) from 564 and 1886 M. respectively. The frontal membrane generally extends nearly to the end of the outer distal angle (fig. 1), but the frontal wall of the triangular point may be calcified, and the point then becomes a complete, unjointed spine, as shown by MACGILLIVRAY (1883, fig. 1 *a*). The basal wall is traversed by a conspicuous zigzag line (figs 4, 5), often bright red in dry specimens. These lines represent regions where calcification is deficient, since when

treated with Eau de Javelle the zooecia separate along them; and they are clearly joints. At the distal end of the basal surface of the zooecium, each angle of the zigzag gives off a similar line, which passes round the outer border of the branch to the frontal surface. Here it still runs transversely, just distally to the end of the zooecium, until it reaches the zooecium of the other side of the branch; but this part of the joint is generally concealed by the distal projection of the zooecium, and is not shown in the figures.

The basal surface may be evenly convex, but in many cases, particularly among the paler specimens, it bears a conical, distally directed, calcareous projection (fig. 5). This may be produced into a long, cylindrical tube, which remains near the back of the branch, sometimes exceeding the zooecium in length (fig. 4).

The bifurcation is shown in fig. 4. Near the proximal end of the colony, where rootlets are abundant, some of the zooecia are narrower than usual, with no projecting external angle; and these may form a short stalk. In one case (286. B) some of these proximal zooecia have their outer sides strengthened by two parallel calcified bars, corresponding with the arrangement found in *B. vectifera*.

The communication-pores are arranged as shown in fig. 6. The proximal equitant end of the zooecium bears a row of about 10 septula. On the outer side of this part, near the distal angle, are about three pores, one of which is distinctly larger than the others. The proximal part of the external wall has a row of septula. On the inner side, the zooecium is in contact with two zooecia of the opposite side of the branch; and each of these septal walls has several pores. The tentacles are about 24.

Ovicells are developed in profusion, and although usually broader than long they are occasionally longer than broad. The narrow stalk ends in a circular pore, leading to the space between the two layers of the ovicell. Although situated at the distal end of the zooecium I believe that the pore communicates with the inner branch of the equitant proximal end of the succeeding zooecium. A communication with the distal zooecium is figured, in *B. sabatieri*, by CALVET (1900, TIZM, n.s., 8, pp. 29, 57); and this arrangement shows that the ovicell of *Bugula* is formed partly by that zooecium, as is the case with other ovicells of the hyperstomial type. The circular thickening band surrounding the aperture of the ovicell (fig. 3) is a characteristic feature of *B. robusta*.

The development of the ovicell in the Bicellariellidae has been frequently described, and reference may be made specially to NITSCHE (1869, ZFWZ, XX, p. 3), VIGELIUS (1886, MZSN, VI, p. 512) and WATERS (1909, JLS, XXXI, p. 135); the last being concerned with *B. neritina*. The ovicell consists, as usual, of a membranous vesicle (text-fig. 1, C, *M.V*, p. 202) at first subspherical but later depressed into a cup in which the embryo lies, and the two-layered hood which projects over the vesicle.

2. *Bugula philippsae* n. sp. (Pl. XXX, figs 9, 10; Pl. XXXII, figs 8—11; text-fig. 23, A, p. 433).

Bugula dentata Philipps (nec auctt.), 1899, WZR, pp. 440, 443. Lifu, Loyalty Is.
(?) *Bugula ditrupae* Thornely, 1907, MPIM, p. 183. Andaman Is (no description).

637. B. Stat. 2. Madura Strait, 56 M.
Type. 41. A. } Stat. 77. Borneo Bank, Strait of Makassar, 59 M. (Also on slide 39. B, *Caulibugula*
385. J. } *separata*; and (385. J) on slide 385. A, *Bugula dispar*.)

415.G.) Stat. 318. Off Kangeang Id, N.E. of E. end of Java, 88 M.
643.A.)

263.A.) Stat. 319. Java Sea, 82 M.
626.A.)

555.C. Stat. 320. Java Sea, 82 M.

Cambridge, Mus. Zool.: —

BM Lifu, Loyalty Is (as *B. dentata*), A. WILLEY (Miss E. G. PHILIPPS), Reg. Mar. 1, 1898.

Zoarium reaching a length of about 32 mm., borne on a stalk consisting of a short series of kenozooecia, passing into uniserial, turbinate zooecia with a short opesia surrounded by numerous spines; later becoming biserial, when the adult characters are acquired, as follows. — Branches narrow, not spirally arranged, biserial, of uniform width, not interrupted at the junctions of the zooecia, which have straight external margins. Outer part of zooecium strongly inrolled, the frontal membrane thus facing obliquely towards the axis of the branch. Opesia elongate, its narrower proximal end not far removed from the preceding zooecium. Two inner distal spines, diverging from a single point; one outer distal spine and two others on its proximal side, projecting inwards over the frontal membrane. Avicularia (Pl. XXXII, fig. 11) at the base of the colony near the proximal ends of the zooecia, becoming more distal on the younger zooecia; of medium size, the upper profile passing in a nearly straight line from the most prominent part of the head to the rostrum, which is strongly hooked. Ovicells globose, directed obliquely outwards, where they extend beyond the edge of the branch. Rootlets fine, seldom branching.

The characters of *B. philippsae* are very constant; and the inrolled margin of the zooecia, the number, form and position of their spines, the position of the ovicells and the mode of origin of the colony are all distinctive features.

The colony represented in Pl. XXX, figs 9, 10 commences with a rounded swelling separated by a constriction from the rest of zooecium 1, which is probably the ancestrula. This zooecium is turbinate, with a short opesia, surrounded by spines; and it gives rise to two daughter-zooecia. One of these, A, resembles the ancestrula, and produces a similar, but rather longer, distal successor, the branch being incomplete. — The other derivative (2) is a kenozooecium, with a vestigial opesia and without spines; and this is followed successively by the kenozooecia 3, 4 and 5. The zooecia A and 1—4 bear numerous rootlets, which are delicate, narrow and unbranched. Each originates from a circular, plano-convex rosette-plate. The proximal end of each kenozooecium is strongly forked, like those of the ordinary zooecia. No 5 is succeeded by an elongate, turbinate zooecium (6) with a very short opesia, surrounded by 10 spines. Three similar, but much shorter zooecia (7—9) follow in succession, each with about the same number of spines. The branch then becomes biserial, the proximal member (10) of the pair having five instead of three external spines, and after this point the typical adult number is retained throughout. The spines are all unjointed, and the proximal external spine is usually broad. The lumen of the other three is constricted near the base, by thickenings of the calcareous wall (Pl. XXXII, fig. 10); but the two inner spines, which are more slender, show only a slight indication of this structure. The other colonies have a similar proximal end, the number of kenozooecia being, however, variable.

The ovicells (fig. 8) are directed obliquely outwards, so that their margin extends beyond that of the edge of the branch. The avicularia in the proximal part of the colony (Pl. XXX, fig. 9) originate from the gymnocyst, on its frontal surface and on the outer side of the middle line, usually before the commencement of the opesia. In the younger part of the colony they are more distal, until, near the ends of the branches, they occur just on the proximal side of the bases of the outer spines, on the basal or lateral part of the inrolled margin of the zooecium.

A similar migration of the avicularia, in passing from the proximal to the distal end of the colony, is noticed under *Caulibugula dendrograpta*, to which *B. philippsae* shows a distinct approach, in its stalk composed of kenozooecia.

At the bifurcation (text-fig. 23, A; Pl. XXXII, fig. 9), the axillary zooecium (E), which may be provided with an ovicell, is completely excluded from the axil. The proximal end of G is in lateral contact with the middle of F, into the body-cavity of which it gives off a connecting process (*c.p.*), which joins the inner limb of the proximal fork of H.

B. philippsae is closely related to *B. ditrupae* Busk (1858, QJMS, VI, pp. 125, 261, Pl. XX, fig. 7, 8), from Madeira. The base of the colony in this species, as shown in Madeiran specimens in the British Museum, resembles that of *B. philippsae*; and this point is illustrated by a specimen referred to *B. ditrupae* by Hincks (1886, AMNH, 5, XVII, p. 261, Pl. IX, fig. 3). A similar retention of presumably ancestral characters, in other species of the genus, has been recorded previously, as for instance by Nitsche (1869, ZFWZ, XX, Pl. I, fig. 7) and Waters (1897, JLS, XXVI, p. 11; — 1900, JLS, XXVIII, p. 54, Pl. VII, fig. 13). *B. philippsae* appears to differ from *B. ditrupae* in the greater development of its stalk, which has a succession of uniserial kenozooecia and zooecia of primitive type, in the numerous slender rootlets, the oblique ovicells and the shorter avicularian rostrum, and in the constancy of the number of the spines. It seems to be also related to *B. dentata*, a species with which it has probably been sometimes confused.

3. *Bugula dentata* (Lamx). (Pl. XXX, figs 5, 6; Pl. XXXII, figs 21—25).

Acamarchis dentata Lamouroux, 1816, PCF, p. 135, Pl. III, figs 3*a*, B. Australasia.
Acamarchis tridentata Krauss, 1837, BKC, p. 31, Plate, figs 2*a*—*c*. Cape Colony.
Bugula dentata Busk, 1852, BMC, p. 46, Pl. XXXV, figs 1—5. S. Africa.
Bugula dentata MacGillivray, 1883, PZV, VIII, p. 30, Pl. LXXVIII, figs 3—3*c*. Victoria.
Bugula dentata Ortmann, 1889, ANG, LVI, 1, p. 25, Pl. I, fig. 20. Japan.
Bugula dentata Kirkpatrick, 1890, TS, p. 614. Torres Straits.
Bugula dentata Waters, 1897, JLS, XXVI, p. 12; — (pars) 1918, JLS, XXXIV, p. 5, Pl. I, fig. 1. Cape Verde Is.
Bugula dentata Calvet, 1906, RSZ, XIV, p. 617, Pl. XXI, fig. 1. Amboina.
Bugula dentata Norman, 1909, JLS, XXX, p. 285, Pl. XXXVI, fig. 3. Madeira.
Bugula dentata Levinsen, 1909, MSSB, p. 101, Pl. V, figs 1*a*, *b*.
Bugula dentata Thornely, 1912, PIOS, p. 141. Amirante Is (Indian Ocean).
Bugula dentata Yanagi and Okada, 1918, AZJ, IX, p. 421 (no description). Japan.
Bugula dentata Marcus, 1922, AI, p. 422, Pl. XXIV, fig. 1. Aru Is.
Bugula dentata O'Donoghue, 1924, BP, p. 33. Cape Colony.

602. B. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
31. E. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M.
337. F. Stat. 71. Makassar, S. W. Celebes, 0—32 M.
89. C. Stat. 116. Kwandang Bay, N. Celebes, 72 M.
108. H^2. Stat. 144. S. of Halmaheira (Djilolo), 45 M.

505. C. Stat. 164. W. of N. end of New Guinea, 32 M.
516. B. Stat. 173. Off E. coast of Ceram, 567 M.
191. B. Stat. 274. Off Jedan, Aru Is, 57 M.

Cambridge, Mus. Zool.: —

Torres Straits, 115, A. C. HADDON, Reg. Feb. 24. 1898.
Singapore, 5—10 fath., F. P. BEDFORD, Reg. Nov. 11, 1899.
BM Port Elizabeth, S. Africa, Miss E. C. JELLY, Reg. May 9, 1895.

Zoarium resembling that of *B. philippsae*, but not originating from a stalk formed of kenozooecia. Branches biserial, narrow, of uniform width, the distal edges of the zooecia hardly projecting. External margins of zooecia inrolled, generally less so than in *B. philippsae*; the frontal membrane more or less oblique. Opesia occupying most of the frontal surface, narrower proximally. One inner distal spine, three outer spines, generally long and jointed at the base. Avicularia of two kinds, the ordinary ones elongate, on the outer side of the opesia. Specially large avicularia (not always present) with a long, shallow, weak rostrum and a trifoliate mandible, frequently developed on two of the outer zooecia at a bifurcation, and less commonly on other parts. Ovicells globose, directed obliquely inwards, so that no part projects beyond the edge of the branch. Rootlets relatively coarse.

B. dentata is distinguished from *B. philippsae* by the want of the peculiar stalk of that species, by having only a single inner distal spine, by the more elongate external spines, jointed at their base, by the occurrence of two kinds of avicularia, and by the inwardly directed ovicells, a point specially emphasized by CALVET in describing specimens from Amboina. As in the other species, the spines are very constant in number, though varying in size. The outer spines are often of great length and have the character shown in Pl. XXX, fig. 5. A proximal, cylindrical pedicel is marked off from the next portion, at the base of which the lumen of the spine dilates. The main joint is commonly found on the distal side of the pedicel, which may consist of two or even three succeeding cylindrical segments. The spines may be equally developed on both sides of the branch, but in the specimen from Port Elizabeth the spine of the inner side of the branch is usually small and weak, and very large spines occur on the outer sides of the branches.

The ordinary avicularia (Pl. XXXII, fig. 24) are rather more elongate than those of *B. philippsae*, the upper profile of the rostrum being slightly concave instead of straight. The hook of the rostrum is obscurely trifoliate. The large avicularia (figs 21, 23, 25), which are in the same positions as the others, have been observed in 31. E, 89. C, 337. F, 505. C, 602. B, and in the specimen from Singapore; and MARCUS has found them in material from the Aru Is. The S. African specimen has lost all its avicularia. In most cases the large avicularia are present on some of the bifurcations (fig. 21), on the two zooecia C and D, but I have found them more rarely in other parts of the colony. Their rostrum is elongate, shallow, boat-shaped (fig. 25) and relatively weak. The occlusor muscles occupy a small proportion of the head, and the mandible (fig. 23) is broadly trifoliate, with a slender terminal spike.

B. dentata can easily be recognised by the obliquely inward direction of the ovicells (fig. 21), a point which is well represented in BUSK's figures. The rootlets are distinctly coarser than those of *B. philippsae*, sometimes expanding greatly as they leave the base of the colony,

and contributing to the formation of a short stalk. The basal surface of the zooecium has several pores, and in particular a large oval pore (Pl. XXX, fig. 6, *p.*), close to the outer branch of the forked proximal end of the succeeding zooecium. The bifurcation is shown in Pl. XXXII, fig. 22.

The description of *B. dentata* given by LAMOUROUX is hardly recognisable; but MACGILLIVRAY, who with other authors has also recorded this species from Australia, expressed himself as satisfied that LAMOUROUX' name can be used in this sense. *B. dentata* appears to have a wide distribution, from S. Africa up the W. coast to the Cape Verde Is and Madeira, as well as on the Australian and Japanese coasts. Most authors describe it as being of a grey or bluish colour. The large avicularia are not always present, but the other characters given above seem to be very constant.

4. *Bugula pedata* [1]) n. sp. (Pl. XXXII, figs 12—14).

418. A. Locality not recorded. One colony.

Zoarium not definitely stalked, the base composed of zooecia giving off strong rootlets, expanded at their attachment. Branches biserial, with a tendency to become 3- or even 4-serial at the distal bifurcations. External surface of zooecia inrolled, the frontal surface facing towards the axis of the branch, the opesia not occupying more than two thirds of the frontal surface except at the bifurcations. Spines small, unjointed, variable in number. The typical number seems to be 2 outer and 1 inner, but may be: outer 3 or 1 and inner, 2. Avicularia on the edge of the inrolled external margin, the head prominent, the upper profile straight and the rostrum short. Ovicells not found. Bifurcation of type 5 or 4.

This specimen has some resemblance to *B. philippsae*, from which it differs in the much stronger rootlets and in the proximal part of the colony, which does not exhibit the special characters of that of the other species. The rootlets (fig. 12) are remarkably stout, strongly calcified, relatively short and usually unbranched, and they expand in nearing their region of attachment, which is commonly foot-like. Near the base of the colony the spines may be rather more numerous than distally, an extra spine having been observed near the proximal end of the opesia, on its outer side. The mode of bifurcation varies according to its position in the colony. Near the base it is of type 4, as shown in fig. 13, the axillary zooecium (E) being free distally on its inner side, its basal surface being crossed by the proximal limb of the fork of G, joining a connecting process (*c. p.*) given off by F. More distally in the colony the bifurcation is of type 5, the split dividing the branches not extending so far proximally, so that E remains completely immersed, the branch being at this level 3- or even 4-serial. In this part the connecting process is formed by G and joins the proximal end of H.

The avicularia (fig. 14), which closely resemble those of *B. philippsae*, are developed in profusion and are relatively short, particularly in the region of the rostrum, a sense-organ or vestigial polypide being present. They usually occur on the distal half of the zooecium; and one zooecium (slide 418. A[3]) is exceptional in having an avicularium, symmetrically placed, on each side of its opesia. The number of tentacles is about 12.

1) In allusion to the form of the strong rootlets.

(*b*) Bifurcation of type 4.

5. *Bugula vectifera* [1]) n. sp. (Pl. XXXI, figs 1—6).

637.A. Stat. 2. Madura Strait, 56 M.
37.X.
385. I. } Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
Type. 600. C.

Cambridge, Mus. Zool.: —

BM Japan, off Tokyo, 5 AD, 40 fath., A. OWSTON, Reg. June 23, 1902.

Zoarium of delicate texture, commencing with an elongate stalk, composed of zooecia giving off a tangle of bifurcating rootlets, the branches biserial. Zooecia with their frontal surfaces sloping obliquely away from the median raised part of the branch; the obliquity being so great in the proximal part of the colony that these surfaces may be at right angles to one another; elongate, narrow, with an opesia almost reaching the proximal end. Outer distal angle usually with a small conical spine, inner distal border rounded or occasionally with a minute spine. Outer wall of the zooecium strengthened by two parallel, longitudinal, calcareous thickenings, specially developed in the proximal parts of the colony. Avicularia on pedicels at the extreme proximal ends of the frontal surfaces; rather small, with rounded head, the forehead often more or less concave, the rostrum hooked. Ovicells narrowly pedunculate, broader than long, the entooecium with a thickened band round the aperture, the ectooecium thin.

600. C has a delicate stalk, about 12 mm. long, showing the remains of broken branches at distances of about 7, 8 and 10 mm. from the proximal end, where the outlines of the zooecia are obscured by a dense tuft of rootlets, which are coarse, but become smaller by bifurcating. In the more proximal zooecia (fig. 3) the rootlets come off from two lateral rows of rosette-plates, convex towards the body-cavity and in contact with one another. The planes of the two series of zooecia are here at right angles to one another, or even with the two series almost back to back.

B. vectifera is of interest as suggesting the mode of evolution of the stalk of *Caulibugula*. The units of its stalk have the form and size of ordinary zooecia, and though actually devoid of polypides they may have previously possessed them. The stem-zooecia show the calcareous thickenings characteristic of this species in their fullest development. Fig. 6 represents a part of the stalk at the bifurcation, the right series of zooecia being seen in basal view and the left series sideways. The wall *t.*, at the distal end of a zooecium, is the terminal wall, sloping distally away from the basal wall and embraced, as usual, by the forked proximal end of the succeeding zooecium. At the basal end of the terminal wall is a curved calcareous thickening (*a.*), the proximal part of the fork. On the inner side this thickening joins the septum (*l. s.*) separating the two series of zooecia. At its outer end, immediately inside the outer branch of the fork, the curved thickening passes into the main calcareous bar (*c. b*[1].), which runs longitudinally along the lateral part of the basal wall to the proximal end of the zooecium. At its distal end this bar gives rise to an outer branch (*b.*), which passes up the outer side of the terminal wall (*t.*) to the frontal surface. At its proximal end the main bar bends a little outwards,

1) *vectis*, a bar, in allusion to the strengthening bars of the proximal zooecia.

and becomes continuous with a smaller calcareous bar (*c.b*^{2}.), on its outer side and parallel to it. The smaller bar lies either in the actual edge of the opesia or, more commonly, at a short distance from it. When a distal spine is developed, as in the lower left zooecium of the figure, its base can be traced into the smaller bar. After the stalk-region is passed, the zooecia at first show calcareous thickenings, but the distal zooecia do not possess them. Except for the calcareous bars the walls are very thin and delicate.

A uniserial stalk composed of zooecia with calcareous bars of the kind described above would form a suitable starting point for the evolution of the stalk of *Caulibugula*, with its uniserial kenozooecia provided with lateral calcareous thickenings.

The mode of bifurcation of *B. vectifera* is shown in fig. 2, but the connecting process (*c.p.*) is unusually long in this specimen. The axillary zooecium (E) has its opesia completely in the frontal plane, the others having these planes basally inclined, an arrangement which is continued in the two branches.

The avicularia (figs 1, 4) are borne on the short gymnocyst, just proximally to the opesia, usually rather to the outer side of the middle line. The head is swollen, the upper profile is generally concave, and the rostrum is strongly hooked. The tentacles are about 12, and in 37. X they are much pigmented, resembling *B. scaphoides* in this respect. The ovicells (figs 4, 5) are broader than long, with an aperture of corresponding shape, narrower towards the peduncle, and surrounded by a thickened band of the entooecium.

B. vectifera has some resemblance to *B. lophodendron* Ortmann (1889, ANG, LVI, 1, p. 24), from which it differs in the number of spines and in the presence of avicularia, which are wanting, according to Ortmann, in that species.

6. *Bugula scaphoides* Kirkpatrick (Pl. XXXI, figs 7, 8; text-fig. 23, B, p. 433.

Bugula scaphoides Kirkpatrick, 1890, CS, p. 18, Pl. IV, fig. 1. Tizard Bank, 27 fath. (China Sea).
(?) *Bugula robusta* Waters, 1913 (nec MacGillivray), BEA, p. 471, Pl. LXIX, figs 15, 16. British E. Africa.

651.A. Stat. 65a. Tanah Djampeah, between Flores and Celebes, 120—400 M.
37.ZD. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
138.A.) Stat. 164. W. of N. end of New Guinea, 32 M.
141.B.)
661.A. Stat. 250. Kur Id., Kei Is., 0—45 M.
640.A. Stat. 273. Jedan, Aru Is, 13 M.

The following decalcified Siboga fragments are doubtfully referred to *B. scaphoides*.

652. B. Stat. 213. Saleyer, S. of Celebes, reef.
532.A. Stat. 225. Off S. Lucipara Id, Banda Sea, reef [1]).

Cambridge, Mus. Zool.: —

Torres Straits, 116, A. C. Haddon, Reg. Feb. 24, 1898.

Zoarium of a rich red colour, the ovicells and avicularia being white. The branches are biserial, slender, straight and sparingly ramified. Zooecia long, narrow, the outer margin slightly

1) The bottle was marked "Reef", but the depth given in the official List of Stations is 894 M.

concave, the elongate opesia often extending along nearly the whole frontal surface; usually with a minute, conical spine at the outer distal angle, and occasionally a similar spine at the inner distal angle. Avicularia small, compressed, borne on a long, cylindrical peduncle, given off at the proximal end of the zooecium; the head short and sub-globular. Ovicells pedunculate, large, the entooecium marked with numerous hexagonal areas.

The characteristic colour is due to the profuse development of funicular tissue, resembling that of *B. neritina* (Harmer, 1891, QJMS, XXXIII, p. 125). The tentacles, which are about 14, and the alimentary canal are similarly pigmented. Without magnification the species is recognisable by its colour and by its delicate, straight branches, bifurcating at angles of about 45°, the branches about 6 mm. apart. The opesia is long, narrowing proximally, with its inner border projecting in a marked curve over the adjacent zooecium, and its outer border less curved. The operculum has a well marked marginal sclerite, a condition unusual in *Bugula*, and is thus differentiated from the frontal membrane. The basal surface is very convex, and the zooecia are here separated by shallow grooves. The sutural lines are crossed by chitinous joint-lines, of the kind noticed in *B. robusta*. On the outer side the basal wall has a row of pores, at the distal end of which is a larger apparent pore which is really an internal recess from which the occlusor muscle originates. The parietal muscles are in four or five groups, each of about three fibres, on either side.

The short avicularium (fig. 8) is at the proximal end, just distal to the end of the preceeding zooecium. It is carried on a long, cylindrical stalk, given off as a process of the lateral margin, sometimes slightly on the frontal surface. The head is much swollen, the rostrum is of the usual hooked type, and the mandible terminates in an acute spike.

The ovicells (fig. 7) are large, very prominent and longer than wide; and their narrow peduncle is attached to the distal border of the zooecium, on its inner side. The entooecium is conspicuously marked out into hexagonal areas and the ectooecium is delicate. The mode of bifurcation (type 4) is shown in text-fig. 23, B (p. 433).

Rootlets are given off sparsely from the basal surfaces of some of the zooecia, as described by KIRKPATRICK. They are of large diameter and may expand into irregular attaching laminae, with spinous outgrowths from their margins. A similar conformation is found in the type-specimen (89. 8. 21. 13) in the British Museum. Their cavity contains funicular tissue, of the kind found in the zooecia.

138. A is in considerable quantity, but the branches are growing out of Sponges, in which they are completely embedded at their bases. The commencement of the colony has not been found in this species.

7. *Bugula subglobosa*[1]) n. sp. (Pl. XXXII, figs 15—18).

272. E. Stat. 60. Haingsisi, Samau Id, W. Timor, 0—36 M.
Type. 92. E. Stat. 117. Kwandang Bay, N. Celebes, 80 M.
633. A. Stat. 306. Flores, E., 247 M.
250. E. Stat. 310. Sumbawa, E., 73 M.

1) In allusion to the form of the avicularia.

Cambridge, Mus. Zool.: —

BM Japan, off Tokyo, 7. E, 30 fath., A. OWSTON, Reg. June 23, 1902.

Branches biserial, less elongate than in *B. scaphoides*. Zooecia rather broad, the opesia well separated from the proximal end; the outer distal margin obscurely angulate, the inner margin rounded. Avicularia of moderate size, the head globose, not compressed, the rostrum very short; given off at the extreme proximal end of the frontal surface. Ovicells globose, pedunculate, the entooecium not marked with hexagonal areas, strengthened by a thickening band round the aperture. Rootlets coarse, with complicated attaching laminae.

B. subglobosa is nearly allied to *B. scaphoides*, from which it differs by the shorter, broader zooecia, the shorter opesia, the very globose avicularia (figs 17, 18) and the absence of sculpture in the inner wall of the ovicell. The avicularia are borne on distinct pedicels, which usually stand vertically. The spike of the short mandible is given off not quite terminally (fig. 18).

The ovicells are developed from the inner border of the distal margin of the zooecium and are directed so obliquely as to overlap the opposite margin of the branch (fig. 17). From their narrow pedicel the entooecium is thickened as a pair of bars (figs 15, 16), which pass round the frontal margin of the aperture, where they form a very distinct thickening band, in this respect differing from those of *B. scaphoides*. The ectooecium is very delicate. The rootlets, which are not numerous, are thick and expand in passing to their attaching laminae, which are more or less branched and of complicated form.

(*c*) Bifurcation of type 3. (Ovicells generally reduced).

8. *Bugula mollis* [1]) n. sp. (Pl. XXXI, figs 9—11).

Type. 130.D.) Stat. 164. W. of N. end of New Guinea, 32 M.
596.A.)
145.A. Stat. 167. W. of N. end of New Guinea, 95 M.
263.D. Stat. 319. Java Sea, 82 M.

Basal parts of zoarium composed of zooecia surrounded by rootlets. Zooecia only slightly calcified, each branch biserial, transversely jointed at the base. Opesia elongate, not quite reaching the proximal end, strongly inclined towards the axis of the branch; the outer edge generally inrolled, its most prominent portion bearing a long spine, jointed at the base. Another external spine at the distal corner, and a single inner distal spine. Avicularia lateral, rather large, arising from a tubercle at about the middle of the opesia, the upper profile very concave, the rostrum long and strongly hooked. Ovicells vestigial, the frontal wall completely wanting.

In the inrolled external margin of the zooecia *B. mollis* resembles *B. dentata* and *B. philippsae*, from both of which it differs in the number of spines, the arrangement of which is very constant in each of the three species. The definite jointing of the bases of the branches (fig. 11) is a well marked character. The best specimen (596. A) consists of a group of tufts which probably represent a single colony branching from its base and giving rise to several short, parallel stems composed of zooecia covered by rootlets. The more proximal zooecia show some variation. In some cases they are definitely *Bugula*-like, but in 130. D (fig. 9) a proximal

1) In allusion to the small amount of calcification.

zooecium has been found which is turbinate, with a short opesia surrounded by a semicircle of 5 short spines. Extremely long, turbinate zooecia, with short, terminal opesiae, may also occur. In the distal parts the frontal surfaces of the zooecia are strongly inclined towards the axis of the branch (fig. 10), the external margin generally produced into a triangular lobe giving off a long, jointed spine, which may be found, however, without the lobe. A short spine occurs, in addition, at the outer distal angle, and a longer one on the inner side of the rounded border, not quite at its distal end.

The ovicells (fig. 10, *ovc.*) are vestigial, since their frontal walls are deficient. The avicularia are large and elongate, with a strongly concave upper profile and a long, well hooked rostrum. They are given off from the outer border, at about the middle of the opesia, which in fertile branches generally reaches, or nearly reaches, the distal end of the preceding ovicell.

The mode of bifurcation (type 3) is shown in fig. 11. The zooecium A becomes free distally, so that the axillary zooecium (E) is completely free on its inner side. Each of the pairs CE and DF is traversed by a conspicuous joint, near the proximal end; and its normal fork is shared between the two members of the pair, each of which thus has a half fork proximally. The proximal section of E gives off a connecting process (*c. p.*) which slightly overlaps the proximal, unforked end of F.

B. mollis resembles *B. pacifica* Robertson (1905, NCNA, p. 268, Pl. X, fig, 50; Pl. XVI, fig. 101) in the character of its ovicells, but it is much less freely branched and its avicularia are situated more distally. There is no evidence that *B. pacifica* has joints at the bases of the branches.

9. *Bugula dispar* [1]) n. sp. (Pl. XXXI, figs 12—16).

Type. 37. V.) Stat. 77. Borneo Bank, Strait of Makassar, 59 M. (Also on slide 37. X, *B. vectifera*).
385. A.)

Zoarium biserial, delicate, originating from a uniserial row of turbinate zooecia, which have a terminal opesia surrounded by about 10 spines. Opesia of normal zooecia short, with two external distal spines, one longer one, more proximally, on the same side, and one internal distal spine. Avicularia lateral, in the distal half of the zooecium; of two kinds, the larger with a boat-shaped rostrum, the smaller normal, with slightly concave upper profile. Ovicells almost vestigial, represented by their basal wall and by the membranous vesicle, which far surpasses the rest of the ovicell in size.

The short opesia, the number of spines, the dimorphic avicularia and the peculiar ovicells sufficiently distinguish *B. dispar*. The spines are weak, with an indication of a joint at the base. The one most developed is the proximal external, which is borne by the somewhat inrolled external border of the zooecium. The two outer distal spines are sometimes vestigial. The inner spine comes off on the proximal side of the end of the zooecium. The bifurcation (fig. 12) agrees with that of *B. mollis*. The ordinary avicularia (fig. 14) are moderate in size, with a long rostrum and a slightly concave upper profile. The larger avicularia (figs 13, 16), which have been found in 37. V alone, are borne in the same position, here and there, without any definite

1) *dispar*, dissimilar, in allusion to the two kinds of avicularia.

arrangement in the branch. They resemble those of *B. dentata*, but the boat-shaped rostrum is rather deeper and the mandible (fig. 15) is not trifoliate, but has an unusually long and delicate terminal spike.

The ovicells (fig. 13) are very peculiar. They commence, as usual, as a small concave plate (*ovc.*[1]) on the distal side of the fertile zooecium and show the ordinary two layers. Their growth soon stops, while the membranous vesicle (*ves.*) continues to grow, reaching a size much larger than that of the calcareous part. The vesicle and the embryo, which lies in the ovicell, are of large size.

385. A shows the commencement of the colony from a short turbinate zooecium, with a terminal opesia surrounded by a number of short spines. The next zooecium is very elongate, only slightly dilating distally, and in other respects resembling N° 1. It is succeeded by a short zooecium, like N° 1. The stem then bifurcates, but the two daughter-zooecia are not in contact. The larger branch at once becomes biserial for a length of three zooecia, which resemble their predecessors; then bifurcating, the basal member of each branch still retaining the form of the earlier zooecia; after which the adult characters appear. The rootlets are unbranched and very coarse, originating in small number from the sides or basal surfaces of the proximal members of the colony.

10. *Bugula cucullata* Busk. (Pl. XXX, fig. 7; Pl. XXXII, figs 19, 20; text-fig. 23, C, p. 433).

Bugula cucullata Busk, 1867, QJMS, n. s., VII, p. 241, Pl. XXXVI, figs 1—6. Australia, Western Australia.
Bugula cucullata Maplestone, 1882, PRSV, XVIII, p. 50. Victoria.
Bugula cucullata MacGillivray, 1883, PZV, VIII, p. 29, Pl. LXXVIII, figs 2—2*c*. Victoria.
(nec *Bugula cucullata* Verrill, 1879, AJSA, 3, XVIII, p. 52; — 1879, PUSNM, II, p. 188).

541. E. Stat. 257. Kei Is., 0—52 M. One colony.

British Museum: —

Western Australia, Mrs GATTY, 99. 7. 1. 262. BUSK Coll., type-specimen.
Australia, Miss GORE, 99. 7. 1. 263. BUSK Coll.
Victoria, 88. 11. 14. 114, 292. BRACEBRIDGE WILSON Coll.
Victoria, 99. 5. 1. 356—359. HINCKS Coll. (from BRACEBRIDGE WILSON).

Zoarium biserial, without distinct joints. Opesia occupying most of the front, with 2 distal spines on the outer side and 1 on the inner side. Avicularia on the external surface, at the side of the opesia, in the proximal half of the zooecium, but well removed from the proximal end; variable in size, but typically large, with an elongate, strongly hooked rostrum and a markedly concave upper profile. Ovicells cucullate, the frontal calcareous wall wanting.

B. cucullata is characterised by the number of spines, the large avicularia (Pl. XXXII, fig. 20) with a very concave upper outline, and the absence of the frontal calcareous wall of the ovicell (fig. 19). The spines (in the Siboga specimen) are thin, short and with an indication of a joint at the base. In the fertile zooecium the more median external spine lies on the basal side of the ovicell (Pl. XXX, fig. 7). The avicularia are large and strong distally in the colony, but are smaller proximally. The mandible has the usual terminal spike.

The bifurcation (type 3) is shown in text-fig. 23, C. Many of the cucullate ovicells

(Pl. XXXII, fig. 19) contain an embryo, protected by the usual membranous vesicle, which appears to be developed as a small triangular area at the distal end of the fertile zooecium, the longest side of the area coinciding with a transverse line at the base of the ovicell. The opesia of the older zooecia has a small proximal cryptocyst. The tentacles are about 12 or 13.

The colony originates as a single, elongate, turbinate zooecium, cylindrical in its proximal half, then dilating gradually to about twice its original width, and ending in a terminal, circular opesia, surrounded by about 9 short spines. This gives rise at once to two zooecia and produces several coarse rootlets at its proximal end. Similar rootlets are given off, sparingly, by the basal surfaces of a few of the proximal zooecia. They frequently have a sinuous outline and dilate into attaching discs at their ends, without branching.

Miss JELLY (1889, SCMB, p. 30) gave *B. cucullata* Busk as a synonym of *Cellaria serrata* Lamarck (1816, ASV, p. 137). This is clearly incorrect, since LAMARCK described *C. serrata* as closely resembling the species (*C. catenulata*) immediately preceding it in his account; and both species can be referred with some confidence to the Catenicellidae.

BUSK called attention to "the extreme rarity of the avicularia" of *B. cucullata*. His type-specimen is a dry slide, and although a few avicularian pedicels are present the avicularia themselves are wanting. An examination of the entire series in the British Museum indicates that the avicularia are readily lost in dried material. They are present in two slides (99. 5. 1. 357, 359) mounted in Canada balsam. The Victorian specimens differ from the Siboga material in having a smaller proportion of avicularia and in the greater thickness of the two external spines, a character shown in the figures of BUSK and MACGILLIVRAY. These differences do not seem to justify the separation of the Siboga specimen as a distinct species.

MAPLESTONE described the colony as light brown in colour, in the living condition. He gave the number of the tentacles as 12, and stated that the ovicells are "globose when alive; not cucullate, but became so on drying". This obviously refers to the membranous vesicle, which is no doubt similar to that described above in *B. dispar*.

OSBURN (1912, PUSNM, XLIII, p. 277; — 1912, BBF, XXX, p. 225, Pl. XXII, figs 24, 24 *a—c*) pointed out that *B. cucullata* Verrill is a distinct species, and re-named it *B. cucullifera*. It appears to be closely related to *B. cucullata* Busk.

11. *Bugula johnstonae* (Gray). (Pl. XXX, fig. 14; Pl. XXXI, figs 19—21).

Sertularia rigida Lamouroux, 1816, PCF, pp. 190, 191. Australasie (pre-occupied by *Sertularia rigida* Forskål, 1775, Descript. Animal., p. 130).
Sertularia rigida Lamouroux, 1827, EncM, p. 681.
(?) *Sertularia divaricata* Lamarck, 1816, ASV, p. 117. Mers Australes.
(?) *Sertularia divergens* (*errorim*) de Blainville, 1830, DSN, p. 446; — 1834, MA, p. 481.
Halophila johnstonae Gray, 1843, DNZ, p. 292. New Zealand.
Halophila johnstoniae Busk, 1852, BMC, p. 43, Pl. XXX, figs 1—3. Bass Strait, New Zealand.
Halophila johnstoniae Marcus, 1921, IPBS, p. 2. Torres Straits.

92. C. Stat. 117. Kwandang Bay, N. Celebes, 80 M. One colony.

Zooecia biserial, elongate, the opesia more or less oval, usually narrower proximally and broad distally, the inner lateral wall greatly overlapping the adjacent zooecium. Cryptocyst

broad, operculum delicate. Inner limb of the proximal fork of the zooecium greatly elongated. Connecting process of the axillary zooecium (E) extending along the inner side of the proximal end of F. Ovicells well developed, wider than long, and containing the embryo. A toothed calcification commonly present at the proximal end of the body-cavity, attached to its inner wall, the teeth directed obliquely proximally.

This species and the next would be referable to the genus *Halophila* if that genus were recognised as distinct from *Bugula*, a view recently maintained by Levinsen (1909, MSSB, p. 97), who stated that avicularia and ovicells are wanting. Although this is correct with regard to the avicularia, I have found well developed ovicells in *B. johnstonae* and vestigial ovicells in *B. longicauda*. The two species are probably derived from typical *Bugula* by the suppression or reduction of these structures. An operculum, usually unrecognisable in *Bugula*, can be distinguished in both species.

The zooecia (Pl. XXXI, fig. 21) of *B. johnstonae* are moderately elongate, the expanded part forming about half the length visible in frontal view. Joints may be wanting, but one is seen at the distal end of B (across D and F) in fig. 19. The opesia usually has a nearly straight external edge, its inner border being strongly curved and much everted over the adjacent zooecium. A cryptocyst is distinct at the proximal and lateral parts of the opesia. In basal view (fig. 19) the great length of the inner branch of the proximal fork is a conspicuous feature. The retractor muscle originates from near the proximal end of this long branch, into which a considerable part of the polypide can be retracted. There is no special development of pigmented funicular tissue in this specimen.

At the bifurcation (type 3) the axillary zooecium (fig. 19, E) sends off a connecting process (*c.p.*) which lies on the inner side of the proximal body-cavity (F^1) of the zooecium F. B extends across the whole width of its branch, the two daughter-zooecia (D, F) being given off from its basal surface. Rootlets, which are thin-walled and wide, are produced by various parts of the basal surface of the zooecium. Ovicells (Pl. XXX, fig 14; Pl. XXXI, fig. 21) are well developed, and Pl. XXX, fig. 14 shows a foramen (*f.*), between the ectooecium and the entooecium, which opens, as I believe, into the proximal body-cavity of the distal zooecium.

The type-specimen of *Halophila johnstonae*, from New Zealand, is represented by fragments (91. 9. 23. 1) in the British Museum. It was originally a dry specimen, fastened to a tablet, but when discovered by Mr Kirkpatrick, merely a few fragments were left. So far as I can make out from these, the Siboga specimen is correctly determined, and it agrees with material from New Zealand in the Busk Collection at the British Museum. As it appears that two species have hitherto been included under one name, the list of synonyms has to be restricted.

Busk mentioned curious internal calcifications, which I have found in slides from New Zealand and Campbell Id in his collection. The calcifications in question are shown in position in Pl. XXXI, fig. 19, *t.c.*, and, more magnified, in fig. 20. They resemble the pappus-bearing fruit of some Compositae, or a shuttlecock, but the teeth do not form a complete circle. Similar structures have been described by Waters (1898, JLS, XXVI, p. 675) in *Membranipora tehuelcha* (see p. 209) and in *M. nitens* Hincks (1880, AMNH, 5, VI, p. 85). The teeth may perhaps serve as guides for the fibres of the retractor muscle of the polypide, the muscle originating on the proximal side of the calcification; but I have no certain evidence that this is the case.

I am indebted to Prof. BILLARD for the information that, during his examination of the Siboga Hydroids, he had found a specimen [1]) which appeared to correspond with *Sertularia rigida* Lamx and was probably a Polyzoon. At his suggestion I wrote to Prof. VIGUIER, of the Institut Botanique, Université de Caen, who most kindly sent me LAMOUROUX' type-specimens of this species for examination. These consist of three dry fragments pasted on two papers, one labelled "Australasie" and the other "Hab^{t} in India orientali". There can be no doubt that they are identical with *B. johnstonae* (Gray). The specimen marked "Australasie" (to be regarded as the type) is seen in frontal view, and corresponds closely, in the size of its zooecia and in the proportions of the opesia, with my own fig. 21. The grey colour and the deep pigmentation of the remains of the polypide and other tissues are specially significant features. The point on the outer border mentioned by LAMOUROUX is well seen, and the branches are traversed by joints, one of which occurs on the distal side of the zooecium B (as shown in my fig. 19), while another crosses the proximal ends of C and E. On the other paper, which shows the branches in basal view, there is a single ovicell resembling those figured by me. The proximal ends of the zooecia are considerably prolonged, but the condition is not sufficiently good to enable me to state definitely that they agree with my fig. 19. It is fortunately unnecessary to disturb the accepted nomenclature of this species, since *Sertularia rigida* Lamx (1816) is antedated by *Sertularia rigida* Forskål (1775), apparently a Hydroid. In his 1827 work LAMOUROUX gave *S. divaricata* Lamarck, with a query, as a synonym of his own species, and LAMARCK's description seems to render this identification at least possible. DE BLAINVILLE (1830, p. 446; — 1834, p. 481) quoted this species, erroneously, as *S. divergens*. In view of the uncertainty expressed by LAMOUROUX, I do not consider it advisable to accept either of these designations in preference to the name given by GRAY.

12. *Bugula longicauda* n. sp. (Pl. XXX, figs 8, 15, 16).

(?) *Bugula johnstoniae* Ortmann, 1889, ANG, LVI, 1, p. 24, Pl. I, figs 16*a*, *b*. Japan.
(?) *Bugula johnstoniae* Yanagi and Okada, 1918, AZJ, IX, p. 423. Japan.

Type. 656.A. Stat. 170. Between New Guinea and Ceram, 924 M.
152.A. Stat. 211. S. of Celebes, 1158 M.

Cambridge, Mus. Zool.: —

BM Japan, 24. A, off Tokyo, 20—30 fath., A. OWSTON, Reg. June 23, 1902.
BM Japan, 21. A, off Tokyo, 150 fath. Same Collection.

Zooecia greatly elongated (hence the trivial name), usually jointed. Opesia much longer than wide, narrower proximally, its inner margin only slightly everted. A short, unjointed, conical spine usually present at the external distal angle. Operculum strong, Membraniporine, much wider than long; cryptocyst barely indicated. Inner limb of the proximal fork of the zooecium much less elongated than in *B. johnstonae*. Connecting process of the axillary zooecium (E) not bordered by the proximal end of F. Ovicells vestigial, reduced to a small crescent. Tissues of zooecia pigmented.

1) The specimen in question has not come into my hands.

The curious toothed calcifications of *B. johnstonae* have not been found in this species.

The zoarium resembles that of *B. johnstonae*, the branches being long and straggling, the bifurcations occurring at long intervals. The zooecia contain a considerable amount of pigmented funicular tissue and the polypide may also be deeply pigmented. This is a specially striking feature in an unstained specimen (Cambridge Coll., 24. A), from Japan, which looks as if it had been deeply stained with nigrosin, the colonies in spirit being of a dark black colour.

B. longicauda is distinguished from *B. johnstonae* by its much longer zooecia, the smaller development of the inner limbs of their proximal ends, its elongate opesia and its vestigial ovicells. The zooecia differ from those of the other species in several respects. The long opesia has but little eversion of its inner margin, and the cryptocyst is hardly indicated. As in *B. johnstonae*, the external distal spine is typically present and strong, but may be wanting. The proximal part of the zooecium is very long and is often jointed, especially at the base of a branch (fig. 8). The retractor muscle originates near the proximal end of the fork. At the bifurcation (fig. 8) the connecting process (*c.p.*) of the axillary zooecium (E) joins the proximal end of F, instead of extending along its free border.

In 152. A the base of the colony was surrounded by rootlets, forming a definite stalk and spreading out at its base into a tuft attached to Foraminiferal ooze. The tentacles are about 24; and, as in several other Polyzoa brought up from deep water, they are not infrequently protruded.

The ovicell (figs 8, 15, 16 *ovc.*) is vestigial and reduced to a small crescent. The cavity between the ectooecium ann the entooecium opens by a foramen (fig. 8, *f.*) into the proximal fork of the succeeding zooecium, indicating the morphological derivation of part of the ovicell from that zooecium. It may be noted that the proximal margin (*b.w.*) of the fork is presumably the angular basal edge of the distal wall given by Levinsen (1909, MSSB, p. 97) as part of his diagnosis of *Halophila*. The ovicell occurs at the distal end of a fertile zooecium, which produces an ovary on its inner wall, near the middle of its expanded portion. This organ is at first minute, with undeveloped eggs (fig. 8, *ov.*), but when further developed it has a large egg, containing much yolk (fig. 15, *e.*).

The ovicell is still more definitely shown to be a derivative of the distal zooecium in the Japanese specimen 21. A in the Cambridge Collection. Its zooecial characters agree with those of the Siboga specimens, but the cavity between the two layers of its ovicell is uninterruptedly continuous with the body-cavity of the distal zooecium (fig. 16). The vestigial ovicell thus indicated is of course on the frontal side, and only occurs in certain zooecia, and it is quite distinct from the proximal forked end, which lies, as usual, on the basal side of the zooecium.

The Japanese fauna seems to include more than one species with the general characters of *B. longicauda*, since, in another specimen (27. C, 150 fath.) (BM) from the same collection, well developed ovicells are present (fig. 17), but are of a distinctly entozooecial type, the entooecium being covered by the frontal membrane of the distal zooecium, hardly differentiated into an independent ectooecium. This condition probably represents an intermediate stage in the reduction of the hyperstomial ovicell to a vestige. The zooecia are specially long and narrow, with no definite distal enlargement, and I think it improbable that this specimen is merely a variety of *B. longicauda*.

6. Camptoplites Harm.

Bugula, Sect. β, Busk, 1884, Chall., pp. 37, 40.
Camptoplites Harmer, 1923, JLS, XXXV, p. 300.

Genotype, *Bugula bicornis* Busk, 1884, p. 40.

Zoarium stalked, the stalk prolonged into a tuft of rootlets. Zooecia biserial or pluriserial, more or less expanded distally, narrow and cylindrical proximally. Avicularia borne on long, flexible stalks, greatly exceeding in length the avicularium itself, the mandibles acute. Proximal ends of zooecia not forked. Operculum differentiated. Ovicells hyperstomial. Connecting process, at a bifurcation, giving off two distal branches and a rootlet.

Camptoplites includes a number of species, of which I gave a list in introducing the genus. The majority have been described by Kluge (1914, BDSE, pp. 619—634), from the Antarctic region, mostly in depths of about 385 M., and the genus is typically abyssal. The peculiarities of its species appear to justify separation from *Bugula*; and the mode of bifurcation, as described below, specially supports this view. Of the two species described by Busk, *C. bicornis* is remarkable for having two of the characteristic avicularia on a single zooecium, as well as for having two distinct kinds of avicularia. I have also found two avicularia on a single zooecium in *C. reticulatus*, var. *unicornis*, from the Challenger Station 106.

1. *Camptoplites lunatus* n. sp. (Pl. XXXIV, figs 5—8).

628. C. Stat. 295. S. of W. Timor, 2050 M. One colony.

Stalk composed of a bundle of strong, parallel rootlets, spreading out at the base into a tangle of rooting fibres, which bifurcate several times, their ultimate branches becoming very slender. Proximal zooecia with a short opesia, surrounded by four or five spines. Other zooecia with a longer opesia, narrower proximally, occupying the whole of the expanded portion. Distal spines, one internal and one or two external. Proximal part of the zooecium very long and narrow, not forked at the end. At the bifurcation (fig. 8), the axillary zooecium (E) produces a connecting process (*c.p.*) which is prolonged proximally into an ordinary rootlet, and distally into two more slender tubes, one of which passes along the basal surface of E and the other along the inner basal surface of F. Stalk of the avicularium arising frontally, close to the proximal end of the opesia; the avicularium itself moderately large and nearly semicircular in outline (hence the trivial name). Ovicells not found.

C. lunatus resembles *C. reticulatus*, var. *spinosus* (Waters, 1904, BB, p. 22), from 500 (?) and 569 M. in the Antarctic. It differs from it in the number of spines, in the larger and relatively shorter avicularia and, apparently, in the greater number of rootlets. In fig. 3 *d* Waters indicates a mode of bifurcation identical with that of *C. lunatus* except that the rootlet of the connecting process has a free course, instead of being applied to the basal surface of the branch. The bifurcation of *C. lunatus* (fig. 8) is described above.

The texture of the colony is delicate, and the outer part of the zooecium is often folded over the opesia, a position which appears not to be natural. Numerous rootlets are produced by various parts of the basal surfaces of the zooecia and run along the basal surface. In

addition to these, stout calcareous tubes, probably modified rootlets, are given off, sometimes at the distal end of a zooecium (fig. 8, *C*), or replacing the inner spine, or in other positions. They clearly correspond with the similar structures which, in *C. reticulatus*, form connexions between the branches (Busk, 1884, p. 40). There is some evidence that similar unions are formed in *C. lunatus*, but the tubes are nearly all broken and this point is uncertain.

Except in the more proximal zooecia (fig. 5) the distal spines are normally 1—1 at the two corners; but two external spines, close together, may occur. The stalks of the avicularia (fig. 6) are very long, their walls probably impermeable and therefore crumpled by the action of reagents. They do not seem to contain muscles, which Busk supposed to be the case, and they are probably cylindrical and filled with fluid during life. I have found one avicularium which had grasped a Foraminiferan larger than itself. Its load may have been heavy enough to depress it, so that it would have been able to deposit it in some position where it would not interfere with the zooecia, then presumably springing back by the turgidity of its stalk. The remarkably elongated stalks may in fact have been evolved to enable the avicularia to keep the colony free from intrusive particles of the ooze. The avicularium (fig. 7) is an asymmetrical semicircle, somewhat pointed at the rostral end, which bears a minute hook. The oblique calcareous thickening which separates the rostrum from the head, in *Bugula*, is wanting. The mandible has a strong spike, given off not quite terminally.

Well developed hyperstomial ovicells have been described by Busk in *C. reticulatus*, and by Kluge and by Miss Thornely (1924, AAE, p. 5) in several Antarctic species. They were not found in *C. lunatus*.

7. Himantozoum Harm.

Bugula, Sect. *α* (pars), Busk, 1884, Chall., p. 37.
Himantozoum Harmer, 1923, JLS, XXXV, p. 311.
Genotype, *Bugula mirabilis* Busk, 1881, QJMS, XXI, p. 12; — 1884, Chall., p. 39.

Zoarium stalked, attached by a basal tuft of rootlets, unilaminar. Zooecia biserial to multiserial, usually asymmetrical when marginal, the more centrally placed zooecia of the multiserial branches symmetrical, producing large eggs which develop in the cavity of the zooecium (not observed in all the species). Ovicells wanting. Aperture occupying the entire front, an operculum being differentiated. Proximal ends of zooecia strongly forked, overlapping their predecessors largely on the basal surface. Avicularia at the proximal ends of the zooecia, unjointed at the base, symmetrical or asymmetrical, the mandibles acute. Bifurcation as in Pl. XVIII fig. 13.

The species, additional to the genotype, which I have already referred to *Himantozoum* are: —

Bugula leontodon Busk, 1884, Chall., p. 39. S. of Canary Is, 1525 fath.
Bugula sinuosa Busk, 1884, p. 39. Marion Is, 80—150 fath.
Bugula margaritifera Busk, 1884, p. 41. E. of Buenos Aires, 1900—2200 fath.

Bugula versicolor Busk (1884, p. 38), the first species included by Busk in his Sect. *α*, differs from the others, as I have previously pointed out, in having large entozooecial ovicells,

in the unforked proximal ends of the zooecia and in the absence of avicularia, and it should perhaps be placed in the Farciminariidae.

1. *Himantozoum taurinum* n. sp. (Pl. XVIII, figs 4, 6, 7, 15).

Type. 156.A., 526.A. Stat. 211. S. of Celebes, 1158 M.
547.A. Stat. 286. S. of E. Timor, 883 M.

Zooarium at first biserial, becoming later at least 3- to 5-serial. Zooecia elongate, frontally of nearly uniform width, on the basal side narrower proximally than distally. Operculum distinct and long, especially in the fertile zooecia. The more proximal zooecia are spineless, those at the margins of the branches situated higher in the colony with an external, short, conical spine at the outer distal angle, as in *Bugula johnstonae*. When the number of the longitudinal rows is increased beyond two, the marginal zooecia are asymmetrical, as in the biserial parts. Those of the median rows, 1—3 in number, are bilaterally symmetrical. In the fertile parts the marginal zooecia commonly possess a strong, internal distal spine, in addition to the outer short spine, and the median zooecia have a pair of distal spines, which are curved like the horns of a bull (hence the trivial name). Some of the spines of the median zooecia bear a short prong near the base. Avicularia large, the median ones larger than the others and symmetrical, the marginal avicularia asymmetrical; in both cases originating from the extreme proximal end of the zooecium, on the frontal surface, by an unjointed base of moderate width, and then dilating into a broader head, with a terminal rostrum.

The zoarium resembles Busk's figure (1884, Chall., Pl. X, fig. 3) of *H. leontodon*, and this figure gives a satisfactory representation of the present species as well. 547. A is 49 mm. long, its stalk 9 mm., composed of a bundle of parallel calcareous rootlets, which bifurcate when they have become free in the basal tuft, where their branches are attached to Foraminifera. Fig. 7 shows a fertile branch composed of 4 rows, the marginal zooecia being asymmetrical, the median ones symmetrical. Although all the median zooecia are perhaps potentially fertile, eggs have not developed in all of them, and the actually fertile zooecia are broader, with larger opercula, than those which have not produced eggs. In the fertile zooecia drawn, the great length of the operculum may be specially noted, as well as the conspicuous, forked, distal spines. The frontal membrane of these median zooecia, whether fertile or not, is greatly depressed, the lateral margins standing up, far above the level of the membrane. This depression is so great at the proximal end that the large median avicularia do not rise above the level of the free edges of the lateral walls. A similar arrangement occurs in *H. leontodon*, where the frontal membrane is overarched by strong, tooth-like spines. The marginal avicularia stand out obliquely from the distal borders of the zooecia. I have had some difficulty in deciding whether the avicularia are proximal or distal structures, but I have convinced myself that they arise from the extreme proximal ends of the zooecia, their base being usually concealed by the projecting oral arches of the preceding zooecia. That this is their real position is confirmed by the arrangement in *H. mirabile*, in which, as shown by Busk (1884, Pl. X, figs 1 *a*, *b*) and by the type-material, the avicularia originate at some distance from the distal end of the preceding zooecium.

The basal view (fig. 4) shows the considerable overlap of the proximal ends of the zooecia, beyond the distal walls (*d. w.*), as well as their forked ends. In the median zooecia the proximal end of the zooecium overlaps the whole width of its predecessor. In the marginal members the overlap is much longer, but it does not cover the outer part of the zooecium. The figure also shows a comparatively young and spherical egg in one of the fertile zooecia, while in two others the egg has grown to a large size, filling almost the entire width of the zooecium and much of its length. In other fertile zooecia (not shown) a minute ovary, in which none of the cells have developed yolk, occurs on the middle of the basal wall, in the distal half of the zooecium.

The form of the marginal and median avicularia, in both of which the mandible has a terminal spike, is shown in figs 6, 7. Fig. 15 illustrates a strengthening arrangement characterising the marginal zooecia which have lost their polypides, near the proximal end. A number of calcareous bars are produced by the basal and external walls, as projections, often vertical laminae, into the body-cavity, running freely through it in some parts. Though irregular in position, they are usually obliquely longitudinal, and their attachment to the basal wall gives rise to a conspicuous pattern, visible in transparent preparations.

The branch usually becomes 4- or 5-serial before bifurcation takes place. In either case it simply splits without any further doubling of the zooecia, the resulting branches being, in the first case, both biserial at their commencement, while in the second case one is biserial and the other triserial, already provided with a median row. In both cases the inner row of each branch is formed by a continuation of one of the median rows before the bifurcation, and its constituent units take on the asymmetrical character at once. When further rows are added, the first is formed by the doubling of the zooecia in the outer series, corresponding with a marginal row before the bifurcation; while the next two, in the case of a biserial branch, are formed alternately on the two sides. The manner in which a biserial branch becomes triserial is as in *H. emaciatum*, described below.

Rootlets are developed in profusion from the more basally situated members, apparently only from the marginal zooecia, on the outer sides of their basal walls. They run down the basal side of the branch, to which they are closely attached, at first leaving the middle uncovered. Nearer the base the whole surface becomes covered, and the rootlets are prolonged beyond the most proximal zooecium as a stalk which consists solely of parallel rootlets. The ancestrula has probably been raised above the ooze by the progressive growth of the rootlets, which increase in diameter towards the basal tuft, where they are extremely broad and strong, subsequently bifurcating repeatedly, with diminishing diameter, so that the ultimate branches are thin and delicate.

The number of tentacles is about 25. The parietal muscles occur in groups, along most of the length of the opesia.

2. *Himantozoum emaciatum* n. sp. (Pl. XVIII, figs 11—14).

Type. 146. B. } Stat. 170. Between New Guinea and Ceram, 924 M.
513. A. }

Zoarium very delicate, about 25 mm. in height, the calcification slight. Branches biserial,

becoming triserial before a bifurcation. Zooecia elongate and narrow, greatly overlapping their predecessors basally. Operculum long, with parallel sides, its distal margin nearly rectangular. A conical, external, distal spine on the marginal zooecia, the median zooecia symmetrical and spineless. Avicularia of one kind, at the extreme proximal end of the frontal portion, in both marginal and median zooecia; elongate and narrow, the base curved and unjointed. Fertile zooecia not found.

In essential features, except for the absence of fertile zooecia, this species agrees with *H. taurinum*, but it is much more delicate in structure. The two specimens found are both rather less than 25 mm. in length, without the basal rootlets; the stalk, to the distal end of the dilated rootlet, measuring 5 mm. The colonies are immature, as shown by the absence of fertile zooecia.

The stalk consists of a bundle of parallel rootlets. In a part of 146. B (fig. 11), which has been broken, there is a dilated rootlet (*r.*), of the same nature as those found in *Euoplozoum cirratum* (Pl. XXX, fig. 1). The lowest zooecium (z^1) may be the ancestrula. At the proximal end the swelling bifurcates, one branch running into a rootlet and the other being broken.

The avicularia (figs 12—14) are characteristically curved, the head being narrow and the palatal surface terminal. The hooked end of the rostrum is little developed; the mandible is shortly triangular, and terminates in a spike.

The mode of bifurcation, with which *H. taurinum* agrees in essential particulars, is illustrated by figs 13, 14. A biserial branch becomes triserial by the production of two zooecia, C and E, from A. The axillary zooecium (E) makes no projection into the bifurcation, although in other cases its outer distal corner may just reach the angle. One branch, at first biserial, is formed by the prolongation of C and E, and their successors; E having the symmetrical form of a median zooecium and forming the commencement of the inner row of marginal zooecia of this branch. The inner proximal corner of G meets the corresponding corner of F, E being thus excluded from the angle of the bifurcation. B and F, with their successors, form the other branch. The walls are so delicate that it has not been possible to make out the whole of the outlines of the proximal forks of the zooecia (fig. 13).

8. **Caulibugula** Verr.

Stirparia Goldstein, 1880, QJMSV, I, Proc., p. 75.
Stirparia Hincks, 1883, AMNH, 5, XI, p. 195; — 1893, ibid., 6, XI, p. 177.
Stirparia Robertson, 1905, NCNA, p. 278.
Caulibugula Verrill, 1900, TCAAS, X, 2, p. 593.
Bugula (pars) Levinsen, 1909, MSSB, p. 101, et seq.
Caulibugula and *Stirpariella* Harmer, 1923, JLS, XXXV, pp. 301, 317.
Stirpariella Marcus, 1925, VMNFK, LXXXI, pp. 37, 47.
Genotype, *Bugula* (*Caulibugula*) *armata* Verrill, 1900, p. 593. Bermuda. Re-described by OSBURN, 1914, CIW, 182, p. 188, text-figs 4, 5, from the Tortugas Is, Florida.

Zoarium commencing with a system of stolon-like kenozooecia, giving off jointed stalks, usually composed of elongate, cylindrical kenozooecia provided with a long opesia and two lateral calcareous thickenings. The branches are biserial (rarely uniserial) and are arranged in groups, usually fan-like in form, the proximal zooecium of the fan more or less different from

its successors and frequently resembling the "Tata" ancestrula of many other Cheilostomes. Zooecia *Bicellariella*-like, sometimes divided into three sections by two joints, turbinate, with a short opesia and long spines; or *Bugula*-like, with an elongate opesia and with vestigial spines or none. Avicularia pedunculate, with an acute rostrum and mandible, variously situated, or wanting. Ovicells hyperstomial but reduced in size, or wanting.

Stirparia was introduced in a notice of a paper by GOLDSTEIN, who stated that the genus was proposed for the reception of a new Bicellariid (not described), "to include also the *Bicellaria annulata* of Mr MAPLESTONE [1]), both species having a peculiar stem which separated them from other genera in the same family". The fuller paper to which this notice referred does not seem to have been published. I have already pointed out that *Stirparia* had previously been introduced, in Coelenterates, by LEUCKART (1841).

Stirparia was more fully defined by HINCKS in 1883, but in 1893 he expressed a doubt whether it should not be regarded as a synonym of *Bicellaria* [*Bicellariella*]; and LEVINSEN definitely referred the species examined by him to *Bugula*. OSBURN (1914, CIW, 182, pp. 188, 189) has shown that *Caulibugula* Verrill is probably a synonym of *Stirparia* [2]).

The fact, illustrated by the species described in this Report, that two types of zooecia occur in *Caulibugula* (see Miss ROBERTSON, 1905, p. 282) has already raised the question whether the two series of species should not be placed in *Bicellariella* and *Bugula* respectively. The modern tendency has been to disregard zoarial characters, but these may be worthy of consideration and, in the present instance, the peculiar stalk (Pl. XXX, fig. 12; Pl. XXXIII, fig. 1), which is alike in both series, may have a generic value. As noticed by previous observers, the initial or proximal zooecium of each of the fans of branches frequently differs from its successors, and may have a striking resemblance to the ancestrula of many other Cheilostomes. WATERS remarks (1910, JLS, XXXI, p. 239), with reference to this and other genera. that "the first zooecium of each subcolony has the form of a primary zooecium", a fact which is in accordance with the results of other authors, particularly of CUMINGS, based on the study of Palaeozoic Polyzoa, and of LANG, referring to Cretaceous species. CUMINGS (1910, Proc. Indiana Acad. Sci., 25th Anniv. Meeting, p. 330, with references to his earlier papers) states that the colony of Polyzoa behaves as an individual in showing a definite recapitulation of ancestral characters. LANG (1905, GM, 5, II, p. 259), who has expressed similar conclusions on several occasions, quotes a statement, by JACKSON, which is even more strikingly applicable to *Caulibugula*, to the effect that in both plants and animals "a new branch tends to recapitulate former characters more primitive than those peculiar to that part ... whence it springs".

The proximal zooecium of the fan of some of the known species of *Caulibugula* is turbinate and is provided with a short opesia surrounded by a complete circle of spines (Pl. XXXIII, figs 1, 5, 15), thus resembling a zooecium of *Bicellariella* and having a more general but still noteworthy similarity to the *Tata* form of ancestrula so common in Cheilostomes (see HARMER, 1902, QJMS, XLVI, p. 320). The opesia may be prolonged proximally into a narrow slit (fig 1, 5), which appears to indicate the reduction of a longer opesia of Membrani-

1) MAPLESTONE, 1879, QJMSV, I, p. 19.

2) I agree with this conclusion, and I regret that in 1923 I overlooked the fact that *Caulibugula* should have been used for *Stirparia*, pre-occupied; my introduction of *Stirpariella* being thus unnecessary.

porine type. In many species the remaining zooecia of the fan are more or less similar to the first zooecium in shape and in the form of the opesia, but generally have a reduced number of marginal spines (figs 1, 5, 15). In *C. dendrograpta* (fig. 1) this reduction may be traced in passing from the proximal to the distal end of a single fan. In a second series of species, for the most part those with an elongate, *Bugula*-like opesia, the proximal zooecium is neither turbinate nor provided with spines. In *C. inermis* (Pl. XXX, fig. 11) it is a kenozooecium, and in *C. mortenseni* (Pl. XXXIII, fig. 20) it is intermediate between a kenozooecium and an ordinary zooecium, and has a *Bugula*-like opesia. In *C. dendrograpta*, in which the first member of the fan is usually of the type shown in fig. 1, I have found an elongate opesia with five spines on each side and one median spine proximally, not unlike the proximal zooecia shown by LEVINSEN (1909), in another species, in Pl. III, figs 1 *d*, 1 *e*. In spite of occasional variations each species normally has proximal zooecia of a definite type.

A gradual transition, from a *Bicellariella*-like zooecium to one of a *Bugula*-like type, is shown in the present series of species, sometimes even within the limits of a single fan (fig. 1). It consists in the elongation of the opesia, and the reduction of the number of spines, which may entirely disappear. These changes are illustrated by *C. zanzibariensis* (fig. 5), *C. dendrograpta* (fig. 1), *C. mortenseni* (fig. 20) and *C. inermis* (Pl. XXX, fig. 11). This series, in which certain characters pass by gradual degrees into others, may indicate that *Caulibugula* has developed independently on lines parallel with those which have been followed in the evolution of *Bugula* from a *Bicellariella*-like ancestor. It is perhaps more probable that the *Bugula*-like condition is the adult form, the occurrence of *Bicellariella*-like zooecia being due to the retention of ancestral characters at the proximal ends of the fans, sometimes partially repeated by the succeeding zooecia

Caulibugula has been found, usually in shallow water, in the Malay Archipelago, the China Sea (Hongkong), India, E. Africa, Western Australia, New South Wales and Victoria; in the Atlantic, off Brazil and Florida, the West Indies and Bermuda; and, in the Pacific, on the coast of California.

MARCUS (l. c.) has just published novel views with regard to the morphology of the stalk and other parts of *Caulibugula*. These are discussed below, under *C. mortenseni*, the species on which they are based.

Key to the Siboga species of *Caulibugula*.

1 Proximal zooecium of fan turbinate, Bicellarielliform, with long spines. Similar spines, jointed at the base, present on the other zooecia. . . . . 2.

1 Proximal zooecium of fan not turbinate, usually spineless. Elongated spines rarely present . . . . . 4.

2 Stalk normal, composed of a series of elongate kenozooecia, strengthened by two lateral calcareous thickenings . . . . . 3.

2 Stalk reduced, consisting of several stem-joints without calcareous thickenings, partially annulated. Inflexed external margin of zooecium terminating in a long spine . . . . . 3. *C. exilis*.

3	Avicularium at extreme distal margin of opesia in the younger zooecia, more proximally situated near the base of the fan, its head very convex. Branches not back to back. Stalk-vesicles not found .	1.	*C. dendrograpta.*
	Avicularium near the proximal end of the opesia, its upper profile nearly straight. Branches back to back, even at the commencement of the fan. Large vesicles, commonly associated in groups, on some of the stem-joints	2.	*C. zanzibariensis.*
4	Branches completely biserial	5.	
	Branches partly uniserial.	4.	*C. separata.*
5	Zooecium and opesia diminishing in width proximally. Avicularia common, at the proximal ends of the zooecia. Stalked vesicles, with rootlets, on some of the stem-joints	5.	*C. mortenseni.*
	Zooecium and opesia as wide, or nearly as wide, proximally as distally. Avicularia and stalk-vesicles not found	6.	*C. inermis.*

C. haddoni, a species recorded by KIRKPATRICK (1890, TS, p. 613, Pl. XV, figs 4—4*c*), from Torres Straits, is not included in the key. The "fan" has been rolled up so as to form an inverted cone, joined by its apex to the end of a jointed stem, and the spineless zooecia have their margins inflexed and face outwards. Avicularia and ovicells were not found. *C. caliculata* (Levinsen) (1909, MSSB, p. 101, Pl. III, figs 1 *a—q*), from Hongkong, resembles *C. haddoni* in possessing conical "fans".

(*a*) Primary zooecium of fan turbinate, with long spines. Long spines, jointed at the base, present on the other zooecia.

1. *Caulibugula dendrograpta* (Waters). (Pl. XXXIII, figs 1—4).

Stirparia dendrograpta Waters, 1913, BEA, p. 470, Pl. LXVI, figs 4—9. Zanzibar, 2 fath.

16. E[1]. Stat. 49[a]. Sumbawa, E., 69 M.
385. H. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
396. Q. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.

Colonies with a creeping, branching stolon, composed of narrow, irregular kenozooecia carrying rootlets. Stems delicate, normal. Primary zooecium of a fan with a short opesia, sometimes with a narrow proximal prolongation, surrounded by 10—12 spines. Subsequent zooecia with an elongate opesia, a distal group of 3—4 external spines, another distal, median spine, and a single inner spine near the middle of the opesia. The spines are very long, and the full number is developed only on the external zooecia of a fan, the median distal spine being often the only one found on the others. Avicularia of the lower zooecia near the middle of the opesia, or even more proximally; of the upper zooecia at the distal end. Ovicells not found (figured by WATERS on the inner side of the distal end of the opesia).

The Siboga specimens, all of which are small fragments, agree with the description of WATERS, who called attention to the ascent of the avicularium along the side of the opesia, in passing from the lower to the upper members of the fan. A similar change in position occurs in *C. armata*, the type-species, as described by OSBURN (1914, CIW, 182, p. 189). The

distal position of the avicularium thus assumed is unusual in the genus. *C. armata* appears to be closely allied to the present species, from which it differs in the smaller number of its spines and in the position of its ovicell, which OSBURN describes as occurring on the outer side of the zooecium, while WATERS distinctly figures those of *C. dendrograpta* on the inner side. *C. ciliata* Robertson (1905, p. 279) resembles *C. dendrograpta* in its spines, but it has a shorter opesia.

The creeping stolons (fig. 3) consist of delicate kenozooecia of irregular diameter, giving off lateral rootlets, which are also produced by the lowest stem-joints at their proximal ends. All these kenozooecia are delicate and slender, and several of them show the distal projection (LEVINSEN's rosette-plate) which marks the origin of the branch.

The lowest zooecium of a fan has the ancestrula-like character above described. Its opesia is short and subcircular, but in the specimen figured (fig. 1) it is produced proximally into a slit. The first zooecium gives rise to two others, and it appears that the full number of spines of the parent is divided between them, so that each has not more than about half that number. It is noteworthy, in this connexion, that it is only the outermost zooecia of a fan which retain the group of external spines. None of these have avicularia in the present material. The other zooecia commonly have only the median distal spine and an inner spine, with an avicularium in the place of the outer spines of the external zooecia.

Successive zooecia arise from one another on the basal side of the distal end, close to the median distal spine (fig. 2). With the exception of the axillary zooecium of a bifurcation, each has a narrow proximal end running down to its parent zooecium. The narrow portion is traversed, as in *Bicellariella*, by two oblique joints; one on the proximal side of the opesia, the other close to the extreme proximal end of the zooecium, the proximal joint of one zooecium corresponding with the distal joint of its lateral neighbour.

The bifurcation (fig. 2) is of "Type 4" (see text-fig. 23. B, p. 433), but the axillary zooecium E has a less tubular proximal end than that of the others and it has only the proximal joint. The connecting process (*c.p.*) is formed by the proximal section of F and joins the inner limb of the proximal fork of G.

The avicularia (fig. 4) have an elevated, convex head and a short, hooked rostrum; the mandible having as usual a terminal spike.

An ovary consisting of a single egg occurs at the proximal end of the caecum of a young polypide-bud, and the tentacles are about 12; — both points in agreement with WATERS.

2. *Caulibugula zanzibariensis* (Waters). (Pl. XXXIII, figs 5—10).

Stirparia zanzibariensis Waters, 1913, BEA, p. 469, Pl. LXVIII, figs 1, 2; Pl LXIX, fig. 14. West Australia, Zanzibar.

1.A.
606.A. Stat. 7. Batjulmati, Java, coral-reef.
16.E². Stat. 49ª. Sumbawa, E., 69 M.
43.F. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
400.B. Stat. 164. W. of. N. end of New Guinea, 32 M.
376.F. Stat. 213. Saleyer, S. of Celebes, 0—36 M.

Stems slightly thicker than in *C. dendrograpta*, the kenozooecia with strong, lateral,

calcareous thickenings bearing rootlets and membranous vesicles. Proximal zooecium of fan with a short opesia, sometimes with a narrow, slit-like, proximal prolongation, surrounded by a variable number of spines; the next pair of zooecia tending to place themselves back to back, a position which is definitely assumed in the branches, on which the orifices face outwards. In the distal zooecia the opesia is about three quarters the length of the frontal surface, more or less triangular, and usually bearing only one spine, at the distal inner angle. The intermediate zooecia may have a larger number of spines, all jointed at the base. Proximal end of zooecium not specially narrow. Avicularia not common, deciduous, elongate, situated laterally, near the proximal end of the opesia. Ovicells small, cucullate.

The Cambridge collection includes a specimen from West Australia, one of the localities given by WATERS, but the proximal zooecia of the fans are not *Bicellariella*-like. I am uncertain whether it should be referred to *C. zanzibariensis*, the type-locality of which may be considered to be Zanzibar, since WATERS' principal figures, on Pl. LXVIII, are stated to be from that place.

The fans usually consist of three branches at their origin, arranged back to back, with the orifices outwards. The spines, which are all jointed at the base, are often found in a reflexed position. They are long in young fans (fig. 5), but become reduced in older ones. The proximal zooecium has 8 or more spines and a short opesia, often prolonged proximally into a slit, as in *C. dendrograpta*. As in this species, external spines are only developed on the outer zooecia, where as many as 5 or 6 may be present. Higher in the fan the number is reduced, often to 2, on the outer zooecia. One or more zooecia, near the base of the fan, may have a very long spine on each side, but spines usually disappear on most of the zooecia, or one alone persists, given off from the inner distal corner of the triangular opesia, which has by this time become at least half as long as the zooecium. There is no median distal spine. The proximal ends of the zooecia are not quite so narrow as in *C. dendrograpta*; and, in correlation with a small amount of calcification, the distal joint is not distinguishable, even the proximal joint being only obscurely indicated in most cases, though it is better developed at the base of a branch.

A lateral tubercle, indicating the former presence of an avicularium, occurs opposite the proximal end of the opesia in a very small proportion of the zooecia, but in most cases the avicularium itself is not present. These structures are obviously deciduous or easily broken off. In one fan only have I found avicularia on most of the zooecia (fig. 8). The avicularium (fig. 9) is elongate, the rostrum of moderate length, pointed and with its sides curved gently outwards. The ovicells (figs 6, 7) are small and cucullate, the calcareous wall being sometimes deficient on the entire frontal surface, though it is in some cases rather more developed. WATERS (1913) has called attention to the deficiency of the frontal wall.

The stem-kenozooecia are stouter than those of *C. dendrograpta*. In the young condition a lateral calcareous thickening runs down the entire length of each side, both frontal and basal surfaces being largely membranous. In the old state (fig. 10) calcification is more extensive, the membranous region being reduced to a median slit, dilating at either end, on each of the two opposite surfaces. The membrane of the frontal surface, which is specially developed distally, represents a frontal membrane, in connexion with which I think I have discovered parietal muscles. Even in the fully developed kenozooecium the lateral thickenings are less than half the diameter of the stalk, except at their two ends, where they dilate to the full diameter.

The stem-joint is formed, like those of the other parts of the zoarium, as a chitinous ring encircling the zooecium at a short distance from its proximal end (fig. 5), each kenozooecium thus contributing to the formation of two stem-segments. The proximal, smaller portion, which constitutes the distal part of the segment, is forked, as described by Levinsen (1909, MSSB, p. 105, Pl. III, fig. 2*f*), in another species; and it corresponds with the similar ends of the zooecia.

The membranous, uncalcified vesicles (fig. 10), a striking feature of this species, are developed, in two series, on the frontal wall of the stem-kenozooecia. Each originates from a septulum which pierces the lateral calcareous thickening of its side. A large proportion of the stem-segments bear these vesicles, most commonly on the distal half, but not confined to this half. Each vesicle is constricted at its base, where it passes into the short stalk of attachment. When grouped, as in fig. 10, the walls of contiguous vesicles are flattened by mutual pressure. A few fine rootlets are sometimes found among the vesicles of a group, but rootlets may be given off singly from other parts of the kenozooecium. Some of the vesicles are solitary, and are then pear-shaped, with a longer or shorter stalk, as shown by Waters (1913, Pl. LXIX, fig. 14). The vesicles are probably modified rootlets, and a considerable part of their cavity is filled with a solid, yellow, amorphous mass, which stains with carmine.

The vesicles of this and other species of *Caulibugula* have been described by Waters (1897, JLS, XXVI, pp. 19, 20; — 1913, BEA, p. 469, Pl. LXIX, fig. 14) and by Levinsen (1909, MSSB, p. 102), who considered that their contents are reserve nutrient materials. In one or two of the Siboga specimens I find Foraminifera adhering to the ends of the groups, which may indicate that they are also used as organs of attachment to the ooze.

In several respects *C. zanzibariensis* resembles *C. occidentalis*, described by Miss Robertson (1905, NCNA, p. 280), from California.

3. *Caulibugula exilis* (MacGill.). (Pl. XXXIII, figs 11—16).

New species of *Bicellaria* Wilson, 1890, PRSV, n. s., II, p. 64. Port Nepean (Port Phillip Heads, Victoria).
Stirparia exilis MacGillivray, 1890, ibid., p. 106, Pl. IV, figs 1—1*b*. Victoria, Port Jackson.
Stirparia exilis Waters, 1913, BEA, p. 468, Pl. LXVI, figs 1—3. British E. Africa.

396. U. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M. Also on slide 396. Q, *C. dendrograpta*, from the same Station.

Colony commencing with a branching system of wide, thin-walled kenozooecia, which ultimately give off very short stalks, usually beginning with two or three short annuli, followed by a single kenozooecium, or by two, without calcareous thickenings. This part is succeeded by the short, annulated commencement of the proximal zooecium, which is turbinate, with a short opesia surrounded by 6—8 long, jointed spines. The other zooecia have similar spines, those of the outer series usually with 2 or 3 external spines distally, another on the inflexed external margin of the opesia more proximally, and often a median distal spine, slightly on the basal surface. In the zooecia nearer the middle of the fan, these spines are commonly reduced to the spine of the inflexed edge and the median distal spine, the latter frequently wanting. Opesia moderately long, facing obliquely, narrower proximally. Avicularia on the frontal surface, at the proximal margin of the opesia, rather large, the forehead convex and the rostrum hooked.

Mandible acute, with the usual terminal spike. Ovicells longer than wide, large, not cucullate. Bifurcation of type 5 (text-fig. 23. A, p. 433).

C. exilis has marked characteristics, particularly with regard to the stem-system, which is so different from that of typical *Caulibugula* that WATERS suggested the possibility of its requiring a genus to itself. It was first mentioned by J. BRACEBRIDGE WILSON, who stated that he found it on a Sponge and that he had given it to MACGILLIVRAY for description. His short note contains the remark "It is a very minute form, but very beautiful, and is specially interesting from its ringed stem, resembling that of *Stirparia*; and suggesting, if not the identity of, at least the close connection between, the two genera *Bicellaria* and *Stirparia*". MACGILLIVRAY stated that the trivial name was suggested by Mr. WILSON, whose note he did not cite. WATERS (1913) found it on a Sponge, in which the lower part of the stem was buried.

In the Siboga specimens (probably all one colony) also, the basal part of the colony was embedded in a Sponge, from which it had to be dissected out. The only parts which reached the surface were the fan-bearing stalks. Some of the embedded portions were on the surface of a small immersed Balanid, which may have been the starting point of the colony. The kenozooecia of this part (fig. 14) are highly remarkable, being wide, thin-walled tubes, of varying diameter, marked by deep constrictions, a few of which correspond with septa across the tube, marking the junctions of two kenozooecia. The wider parts of this system contain a number of granules of a rich brown colour, perhaps excretory in nature. These kenozooecia give off branches of the same kind, usually at right angles, separated from the parent branch by a curved septum, of the kind figured by WATERS (1913, fig. 3). Some of these branches originate near the distal ends of the kenozooecia, the typical position for the branches in *Caulibugula*. Others are not thus situated, and a single kenozooecium may give off two or even three daughter-kenozooecia, but always with a curved septum at the base. As the system approaches the surface of the Sponge, the kenozooecia diminish greatly in diameter (fig. 13), becoming transparent, without granular contents, and acquiring a more cylindrical form. A fan-bearing branch usually originates laterally from the extreme distal end of one of these attenuated kenozooecia. Each commonly has either two or three annulations at its base (fig. 15), followed by a single, rather short stem-segment, or more rarely by two successive segments. The single stem-segment is partly formed, however, by the forked end of the proximal zooecium, this portion constituting a considerable part of the distal end of the stem-segment.

All the evidence at present available shows that *C. exilis* grows on or in a Sponge. It seems probable that this is a definite case of commensalism, and that the difference between this and other species of *Caulibugula* is that its fan-bearing stalks have been reduced to one or two stem-segments, in correlation with a modification by which the greater part of the kenozooecial system has become embedded in the Sponge. Some of the primitive characters have thus been lost, and in particular the regularly cylindrical form of the kenozooecia and the lateral calcareous thickenings, which are completely absent, as pointed out by WATERS (p. 468). The mode of branching remains, however, typical, as shown by the usual occurrence of branches at the distal ends of the kenozooecia, by their separation from the parent by a septum, and by the constitution of the single stem-segment, which is formed by a kenozooecium

proximally and the forked part of the succeeding zooecium distally. If to these points be added the characters of the zooecia and of the bifurcations (fig. 16), the evidence for including *C. exilis* in *Caulibugula* becomes very strong.

Annulations of a similar nature are known in other species, as in *C. caraibica* described by Levinsen, one of whose figures (1909, MSSB, Pl. III, fig. 2*f*) shows an arrangement like that found in *C. exilis*. They are more numerous in *C. annulata* (Maplestone, 1879, QJMSV, I, p. 19), a much more robust and very distinct species.

The proximal zooecium of a fan of *C. exilis* (fig. 15) is quite turbinate, having a short opesia, surrounded by 6—8 long spines, jointed at the base. Eight are shown in the figure, six belonging to the frontal surface, one (seen behind two others to the right) is slightly basal in position, and the eighth (the long one most on the right) springs from the middle of the basal surface, just proximally to the origin of one of the two daughter-zooecia. In each of these there are 3 external distal spines, a median distal one, and another borne by the strongly inflexed external margin of the opesia, a feature in which this species resembles *C. caraibica* (Levinsen, 1909, p. 104) and *C. haddoni* (Kirkpatrick, 1890, TS, p. 613). In other outer zooecia, the group of three is generally reduced to two; while in more internally situated zooecia the most constant is the one on the inflexed angle, while a more distal spine may occur as well, and less often the median distal spine.

The bifurcation (fig. 16) is of Type 5 (see text-fig. 23. A, p. 433), a connecting process of G sending off a distal prolongation of its proximal end along the inner side of F, to meet a shorter prolongation of H. This arrangement has been partly indicated by Waters (p. 468).

Avicularia are not common, and are more frontally situated than in most species; due, no doubt, to the inflexion of the external border of the zooecium. They are found at the proximal end of the opesia (fig. 15), and are elongate (fig. 11), rather large, with a convex forehead and a hooked rostrum. The mandible is not rounded, as stated by Waters, but is acute, with the usual terminal spike. Ovicells are not common, but fig. 12 shows that they are large, longer than wide, and with a well developed, not cucullate, frontal wall.

(*b*) Primary zooecium of fan not turbinate, without long spines. Jointed spines wanting.

4. *Caulibugula separata* n. sp. (Pl. XXXIII, figs 17, 18).

Stirpariella sp. Harmer, 1923, JLS, XXXV, p. 325, Pl. XVI, fig. 2.

39. B. Stat. 77. Borneo Bank, Strait of Makassar, 59 M. One colony.

Stems delicate, composed of much elongated kenozooecia. Branches partly uniserial. Opesia large, narrower proximally, nearly reaching the preceding zooecium. A short, unjointed distal spine on the outer side of the biserial zooecia (less often one on each side), a pair constantly present on each uniserial zooecium. Basal surface hardly calcified, a large membranous fenestra occupying almost its whole extent An elongated avicularium, with an up-turned rostrum, on the inner side of a zooecium at a bifurcation, attached to a lateral tubercle at the proximal end. Ovicells not found.

This very distinct species is characterised by the want of a Bicellariellifform proximal zooecium, by the partially uniserial arrangement of its zooecia (hence *separata*) and by the

curiously restricted position and unusual shape of its avicularia. The stem-segments in the single colony found are nine, the distal one engaged in transverse fission, as described by LEVINSEN (1909, MSSB, p. 106) in *C. caraibica*. The kenozooecia are very long and thin, resembling those of *C. zanzibariensis*. The first one bears a tuft of proximal rootlets, but vesicles have not been found. The stem bifurcates distally, giving rise to two short, diverging, spineless kenozooecia, about the length of a zooecium, and constituting the proximal members of the half fans. Each produces a pair of kenozooecia, still retaining the lateral calcareous thickenings, one projecting more distally than the other in each branch. In one branch the more proximal member has a pair of short distal spines. One or two more kenozooecia follow before the ordinary zooecia make their appearance.

A bifurcation is inaugurated by two zooecia becoming disconnected laterally. One of these (fig. 18, C) is more distal than the other (B), and is almost completely free or disjoined from its lateral neighbour. In one case B produces two daughter-zooecia, but in all others each disjoined zooecium gives rise to a single zooecium, the branches thus becoming uniserial, an arrangement commonly continued by one or two other uniserial zooecia. The distal uniserial zooecium produces two new zooecia, the branch remaining biserial for a length represented by two or three pairs before dichotomising again. In a basal view (HARMER, 1923, Pl. XVI, fig. 2) it is seen that the zooecia originate from their predecessors by the forked proximal end characteristic of this group; and that when a zooecium produces two new ones, the fork is bisected longitudinally, one half belonging to each member of the pair. Joints (fig. 17) do not occur in the middle of a biserial region, but are found at the commencement of both uniserial and biserial parts, and usually at the proximal ends of more than one zooecium of the uniserial regions.

The opesia occupies nearly the entire length of the frontal surface, and is sub-triangular. In some of the biserial zooecia the inner angle is produced into a triangular, pointed lobe, which may be reflexed over the frontal membrane.

The zooecium D at a bifurcation constantly bears an avicularium on its inner, lateral surface, at its proximal end. It is borne on a prominent tubercle (fig. 17), and is elongate, both head and rostrum long and narrow, the rostrum tilted up so that its apex lies well above the main axis of the avicularium. Avicularia have not been found elsewhere.

5. *Caulibugula mortenseni* (Marcus) (Pl. XXXIII, figs 19—22).

Stirparia with "a most remarkable superficial resemblance to a *Rhizocrinus*" Mortensen, 1923, VMNFK, LXXVI, pp. 85, 86. Sunda Strait.
Stirpariella mortenseni Marcus, 1925, VDZG, XXX (Jena Meeting), p. 153, text-figs 1—6; — 1925, VMNFK, LXXXI, p. 37, text-figs 1—12. Sunda Strait.

555. F. Stat. 320. Java Sea, 82 M. One colony.

Stalk composed of delicate kenozooecia, of moderate length, bearing fine rootlets and pear-shaped vesicles with a long, narrow stalk. Proximal member of fan a kenozooecium. Branches biserial, the zooecia long, their outer margin slightly concave, and the opesia very long, narrower proximally. Spines vestigial, sometimes represented by a minute angle or spike at the inner distal corner of the opesia, more rarely by a point on the outer corner (or by a long, unjointed spine distally, at the outer or inner angle; — MARCUS). Avicularia common,

on the extreme proximal end of the zooecium, narrow, elongate. Ovicells pedunculate, broader than long, moderately large.

The remarkable stalk-vesicles of *C. mortenseni* differ from those of *C. zanzibariensis* by having a long, narrow stalk, of the same thickness as an ordinary rootlet. WATERS (1897, JLS, XXVI, pp. 19, 20) has described similar rootlets and vesicles, in "an unnamed species from Kurrachee", but his figure indicates no sharp distinction between a stalk and a swollen head, and no information is given about the characters of the zooecia.

The stalk of *C. mortenseni* is long and composed of many segments. Those near the base (fig. 19) bear large numbers of ordinary rootlets, among which are interspersed others dilating into vesicles, either rounded or pointed at the free end. Each rootlet, whether dilated terminally or not, pierces the calcareous wall separately, starting in a communication-plate projecting with a watchglass-like convexity into the cavity of the segment. A row of these rootlets and vesicles occurs on each side of the frontal membrane of the kenozooecium. Each vesicle contains a compact central mass, which fills a considerable part of its cavity.

The proximal member of the fan is a kenozooecium, shorter than those of the stalk, from which it differs by being slightly widened at its distal end. This gives rise to two ordinary zooecia, each (in one fan) with an avicularian tubercle in the usual place (fig. 20). The zooecia are *Bugula*-like, elongate, curved outwards distally, the opesia occupying most of the frontal surface, its sides parallel or sub-parallel for a considerable distance distally, but becoming narrow proximally. Spines are hardly developed but are represented by vestiges, as indicated in the diagnosis. The gymnocyst is short or of moderate length. At its extreme proximal end it bears an avicularian tubercle, laterally and slightly on the frontal surface. The avicularia, which are present on most of the zooecia (fig. 20), but tend to disappear towards the ends of the branches, are laterally compressed, elongate and relatively large (fig. 22), the head long, the forehead concave and the rostrum hooked. According to MARCUS, an ordinary avicularium may be replaced by a much larger one, as long as a zooecium. The ovicells (fig. 21) are pedunculate and are attached to the inner margin of the opesia distally. They are distinctly wider than long, their frontal calcareous wall not much developed.

The amount of calcification in the zooecia is slight, and joints are not recognisable on most of the zooecia, but can be seen at the bases of the branches. The tentacles are 10—12 (12, according to MARCUS).

MARCUS (l. c.) has suggested an entirely new conception, based on this species, of the morphology of the stalk of *Caulibugula*. According to this view, pairs of zooecia transform themselves successively into stem-segments, in which a complete lateral fusion occurs between the body-cavities and frontal membranes. This conclusion rests mainly on the appearances represented by text-fig. 10 of his second paper, in which (if I understand him rightly) the two lowest zooecia of the fan would shortly have fused into a stem-segment, leaving an indication of the septum originally dividing them at the distal end of the new stem-segment, as figured by him in the uppermost member of the actual stalk. This evidence is, in my opinion, quite unconvincing, and it appears to me that MARCUS has been led to a wrong conclusion by overlooking the fact that each stalk-segment is constituted distally by the short proximal segment of the next kenozooecium or, in the case of the distal segment, by the proximal ends of the

two zooecia which form the base of the fan. There is no essential difference between MARCUS' figures and my own (Pl. XXXIII), but his interpretation of the facts is different from mine.

In the group of species in which the proximal zooecium of the fan is turbinate, Bicellarielliform and provided with long spines (see the first bracket in the Key on p. 458) MARCUS considers that each of these zooecia is an actual ancestrula, formed by the metamorphosis of a larva, and that the colony owes its origin to the fusion of a certain number of originally independent colonies. It remains to be ascertained by actual observation what is the relation of the ancestrula to the rest of the colony, but I myself take the view that the colony originates by branching, even though the proximal zooecia of the fans assume characters which resemble those of an ancestrula. The actual ancestrula can hardly be recognised in a colony, such as that figured by WATERS (1913, BEA, Pl. LXVI, fig. 9), in which numerous fans are produced from a branched kenozooecial system. I doubt whether zooecia can be transformed into stem-segments, a view which was suggested by LEVINSEN (1909, MSSB, p. 102).

MARCUS has described the fusion of the proximal rootlets of a colony to form a single hyaline tube, about 20 mm. long. I have no corresponding observations, but I do not throw doubt on the occurrence of this structure, which appears to resemble the hyaline stalk of *Kinetoskias*. I cannot agree with MARCUS that the ovicell is surrounded by a kenozooecium.

6. *Caulibugula inermis* n. sp. (Pl. XXX, figs 11—13).

	1. B. Stat.	7. Batjulmati, Java, coral-reef. One colony.
Type.	336. E. Stat.	37. Sailus Ketjil, Paternoster Is, 0—27 M. One colony.
	117. A. } 400. E. } Stat.	164. W. of N. end of New Guinea, 32 M. Two colonies.

Stems composed of robust, short kenozooecia, which may attain a great width, the proximal segments producing rootlets but not vesicles. Proximal member of fan a spineless kenozooecium, at least partially divided by a calcareous septum. Zooecia large, elongate, the sides nearly parallel, spineless, a narrow proximal portion hardly represented. Opesia occupying the entire frontal surface, with the exception of a very short proximal gymnocyst. The axillary zooecium at a bifurcation hardly extends beyond the axil. Branches biserial, the terminal ones consisting of numerous pairs of zooecia. Avicularia and ovicells not found.

The name proposed for this species refers to the completely spineless character of the colony. In one case (400. E) the stalk commences as a pear-shaped, proximally pointed structure (fig. 13), which gives off numerous rootlets. This is succeeded by a number of kenozooecia, which are robust and, relatively to their width, much shorter than in most of the species. They have the usual lateral, calcareous bars, the frontal surface (fig. 11) being mostly occupied by a large, membranous opesia; the membranous basal wall being even more extensive and occupying almost the whole of this surface. The stem gives rise to branches, which produce new stems. The width of the kenozooecia varies, some being nearly cylindrical (fig. 12), but others reaching an extreme breadth (fig. 11), greater than that of a zooecium. Two or three of the lowest kenozooecia bear delicate rootlets, arranged in the usual two longitudinal rows. A larger number of them contain a granular material, perhaps analogous to the contents of the vesicles of other species; but vesicles have not been found.

The proximal member of a fan is a kenozooecium (fig. 11), rather shorter than its predecessors, from which it differs in having a partial calcareous septum, at its distal end, indicating the overlap of the next two zooecia. In the figured specimen the partially divided kenozooecium gives rise to two daughter-zooecia, each of which in turn produces two other zooecia. The terminal branches may consist of as many as 12—13 pairs of zooecia.

C. inermis appears to represent an extreme modification of *Caulibugula*, in which spines, avicularia and ovicells have been lost, the opesia has become very extensive and the zooecia have become much simplified in structure.

9. Kinetoskias Dan.

Kinetoskias Daniellsen, 1868, FVSC, Aar 1867, p. 23.
Kinetoskias Koren and Daniellsen, 1877, Fauna litt. Norvegiae, III, p. 109.
Kinetoskias Busk, 1881, QJMS, XXI, p. 1; — 1884, Chall., p. 43.
Kinetoskias Harmer, 1923, JLS, XXXV, pp. 312, 326.
Naresia Wyville Thomson, 1873, Nature, VII, p. 388.

Genotype (selected by HARMER, 1923), *Kinetoskias smithi* [1]) (errorim, for *smittii*), DANIELSSEN, 1868, p. 24. For *Naresia* see HARMER, p. 313.

Zoarium unilaminar, attached to the ooze by a long, delicate, cylindrical, membranous peduncle, which gives off ordinary rootlets at its proximal end. Zooecia biserial, alternate, elongate, the proximal end not forked, with at most vestigial spines, the frontal membrane occupying the entire frontal surface; moveable on one another by the contraction of a special *flexor zooecii* muscle. Lateral rosette-plate single, corresponding with the extreme proximal end of one of the participating zooecia. Method of bifurcation exceptional, the axillary zooecium (E) passing distally into the branch of the side opposite to the side from which it originates (Pl. XXXIV, fig. 10). Avicularia lateral, usually pointed proximally, with acute rostrum and mandible. Ovicells hyperstomial, oblique, the ectooecium and entooecium separated by a relatively large space.

This remarkable abyssal genus has excited much interest, from the time of its first description, owing to its adaptation for fixation in the ooze by means of a stout, but thin-walled, hyaline peduncle. BUSK (1881) gave an excellent account of the genus, agreeing with KOREN and DANIELSSEN (1877, p. 104) that *Naresia* was a synonym of *Kinetoskias*, calling attention to the distinguishing features of several species, including WYVILLE THOMSON's *Naresia cyathus*, and describing a new species, *K. pocillum*. Another species, *K. mitsukurii*, from Japan, has recently been introduced by YANAGI and OKADA (1918, AZJ, IX, p. 425). *K. arabianensis* Robertson (1921, BBB, p. 39) is a synonym of *Euoplozoum cirratum* (see p. 391).

The species of *Kinetoskias* can be distinguished from one another by the position of the avicularium and by the character of the external distal region of the zooecium. *K. cyathus* and *K. mitsukurii* have the avicularium on the "step-like projection" of BUSK (1881, Pl. I, fig. 1), a region partially separated from the proximal part of the zooecium by a sharp emargination of the outer border. *K. arborescens* Dan. (1868, p. 23) is usually described as

1) It was mentioned by M. SARS as "*Bugula Smitti* (*Kinetoskias*) Danielssen" in 1869 (FVSC, Aar 1868, p. 255). I previously expressed the opinion that *smithi* was a printer's error.

having distal avicularia, but I have convinced myself that they are proximally situated, the step-like process being really present, though greatly reduced. In *K. smittii* (Dan. 1868, p. 24), of which *Bugula flexilis* Verrill (1875, AJSA, 3, IX, p. 415; 1879, U.S. Comm. Fish., p. 29) is a synonym, and in *K. pocillum*, the avicularium is on the outer border of the zooecium, at or beyond the middle of its length. *K. cyathus* and *K. smittii* have a minute spine at the external distal border of the zooecium; the other three species being spineless. The new species described below agrees with the first two species in having a spine, and with *K. smittii* and *K. pocillum* in the position of its avicularia. Busk (p. 6) and others have called attention to the presence in *Kinetoskias* of a remarkable muscle which curls the branches inwards, an action observed by Koren and Danielssen in the living condition. Similar muscles, which I have described as the *flexores zooecii*, occur in *Euoplozoum cirratum* (p. 393).

1. *Kinetoskias elongata* n. sp. (Pl. XXXIV, figs 9—11).

557.A. Stat. 161. W. of N. end of New Guinea, 798 M., muddy sand. One colony.
Type. 530. C. Stat. 221. Banda Sea, 2798—3112 M., mud and Foraminifera. One colony.

Zoarium borne by a delicate rooting peduncle, of the form characteristic of the genus. Zooecia elongate, curved outwards distally, with a minute, unjointed spine on the outer distal angle. Avicularia nearer the distal than the proximal end; greatly attenuated at the base, the calcareous part of which comes to an acute point; the head elongate and produced into a boldly curved, acute rostrum. Ovicell large, very oblique, usually broader than long, its two layers widely separated.

K. elongata seems to be nearly related to *K. smittii*, from which it differs in its much longer and more calcified zooecia, in their concave outer border (straight in *K. smittii*), in the shorter avicularia, in the weaker *flexor zooecii* and in the larger ovicell.

557. A. possesses a rooting peduncle 10 mm. long. It is generally assumed that this peduncle projects into the water, but it appears to me possible that the whole, or the greater part, of it may be embedded in the ooze. Yanagi and Okada (p. 426) state that the peduncle (in *K. mitsukurii*) opens externally by a distal pore, but this observation requires confirmation. The peduncle may probably be regarded as a specially enlarged rootlet, comparable with the dilatation of *Euoplozoum cirratum* (Pl. XXX, fig. 1) and other species. The second specimen had lost its peduncle.

The zooecium (Pl. XXXIV, figs 10, 11) ends in a proximal disc, surrounded by a thickened calcareous rim, and does not possess the forked termination characteristic of *Bugula*. The walls are well calcified, basally and laterally, those of *K. smittii* being less calcified. At the outer border, the calcareous rim gives off a strong, vertical tooth, which serves for the origin of the *flexor zooecii* (fig. 10), which is inserted into the basal and lateral walls of the proximal half of the zooecium. In *K. smittii* the fibres are much stronger, and the muscle extends into the distal half of the zooecium. In *K. arborescens* the tooth-like process springs from the midde of the distal border of the preceding zooecium and has the same relation to the flexor.

The bifurcation (fig. 10; see also Harmer, 1923, JLS, XXXV, p. 326, Pl. XVI, fig. 7)

is peculiar, in the fact that the axillary zooecium (E) passes into the branch opposite to the side from which it originated; and, as I find the same arrangement in *K. arborescens*, *K. cyathus*, *K. smittii* and (from Busk's fig. 5, 1881) in *K. pocillum*, this may be considered a character distinguishing the genus from *Bugula*.

One lateral rosette-plate (*l.r.p.*) occurs in the distal half of each zooecium, but I have not observed the arrangement of its pores. A terminal plate is found, in the disc-like junction (*d.*) of two zooecia. The lateral rosette-plates resemble those of *Cornucopina* and *Calyptozoum*. The retractor-muscle (seen in E) originates close to the lateral rosette-plate.

The polypide is small, generally confined to the distal half of the zooecium, and its tentacle-sheath and group of tentacles are conspicuously broad, a feature also noticeable in the polypide-buds. The tentacles are about 28. A small ovary, containing 2 or 3 recognisable eggs, is seen in one of the fertile zooecia, close to its basal wall, at the middle of the zooecium and on the proximal side of the alimentary canal. In some of the neighbouring zooecia, a testis lies on the basal wall, commencing at the proximal end and extending into part of the distal half of the zooecium. A testis has not been observed in fertile zooecia, in several of which a large, elongated egg (fig, 11, ov^2.), containing a considerable amount of yolk, occupies much of the distal half of the body-cavity, applied to the median wall of the zooecium, close to the ovicell. This zooecium has a large egg (ov^1) in the ovicell, as well as one in the body-cavity. The ovicells are very oblique, the entooecium marked by radiating lines, and separated from the ectooecium by a wide space. The attachment is to the inner border of a zooecium, by a short peduncle about $^2/_5$ the width of the ovicell.

The avicularia (figs 9—11) are elongate and compressed, not quite reaching the distal end of the zooecium, whereas in *K. smittii* they surpass it (see Norman, 1893, AMNH, 6, XII, p. 449). The calcareous wall comes to a point proximally, but the membranous attachment to the zooecium is more extensive. The avicularium is widely turbinate proximally, this funnel-like part terminating at the commencement of the frontal membrane. The part of the head containing the paired occlusors is swollen, the forehead slightly concave, and the rostrum boldly hooked in a continuous curve. The acute mandible is curved up towards the palate at its distal end, but it seems to have no definite terminal spike. I have not found the muscle, in the zooecium, which according to Busk (1881, p. 7) moves the avicularium in *K. cyathus*.

Division 6. Cribrimorpha.

Acanthostega Levinsen, 1902, VMNFK, p. 2.
Cribrimorphs Lang, 1916, GM, 6, III, p. 76.

Family Cribrilinidae.

This Family is generally taken to include all recent and fossil forms in which a frontal shield is produced by the union of modified spines (costae) over the original frontal membrane. In certain species, as in *Membraniporella nitida* (Johnston) and *Cribrilina punctata* (Hassall), this process can be observed in the development of the individual zooecia. Levinsen (1909,

MSSB, p. 156) regarded the Family as unnatural, a conclusion I do not accept, but, in view of insufficient material for study, he did not suggest a re-arrangement and retained it provisionally.

Gray's genus *Cribrilina* (1848, BMRA, pp. 116, 147), as accepted by later authors, was broken up by Jullien (1886, BSZF, p. 601), who proposed a number of new genera. It has more recently been studied by others, among whom I may specially mention Norman (1903, AMNH, 7, XII, p. 90) and Waters (1918, JLS, XXXIV, p. 10; — 1923, AMNH, 9, XII, p. 545). The most revolutionary treatment of the group is that of Lang, who in Vols III and IV of the British Museum Catalogue of Cretaceous Polyzoa (1921, 1922), preceded by a series of preliminary papers, has proposed numerous new Families and genera. Although I am inclined to consider his amount of subdivision excessive [1]), I do not feel justified in criticising it in detail on the present occasion. Commencing with *Membraniporella*-like forms ("Myagromorphs", 1921, p. xxxviii), hardly to be distinguished from Membranimorphs (Lang, 1916, p. 76), and with little or no fusion of the costal spines, Lang traces the evolution of the various Cribrimorph series, by increasingly intimate union of the costae and by other changes. While the distal marginal spines commonly remain as a series of free spines related to the orifice ("oral spines" of authors), the first pair of costal spines commonly unite early in evolution to form a proximal border to the orifice; and to this fused pair of costae, which often have characters distinguishing them from their successors, Lang gives the name of "apertural bar" (1921, p. xxxvii). The costae frequently show rounded perforations, where calcification is incomplete, the "pelmata", or "pelmatidia" if smaller, of Lang (p. xli), who regards them as the broken ends of free spines. I do not find this to be the case in recent forms, where a pelma appears to be merely a membranous region of the frontal wall of the costa. They must be carefully distinguished from the pores between two adjacent costae, the walls of which commonly unite in such a way as to transform the primitive slit into a single row of foramina, the "lacunae" of Hincks and Norman, which open into the space between the frontal shield and the frontal membrane.

The more primitive Cribrimorphs retain the original Membraniporine frontal membrane unaltered, a condition well shown by *Membraniporella aragoi* described below, in which that membrane can be seen clearly through the large lacunae. The forms with more complete costal fusions have modified the space between the frontal shield and the frontal membrane into a structure almost as definite as the compensation-sac of the Ascophora, as shown in *Figularia philomela* (Busk), described by me in an earlier paper (1902, QJMS, XLVI, p. 293, Pl. XV, fig. 9). The Anascous forms thus appear to pass almost continuously into the Ascophora; but in the higher group the frontal shield is not typically developed in ontogeny from a series of costae, and it cannot be assumed that its "pores" correspond with the lacunae of Cribrimorphs. It thus appears to me legitimate to regard the Cribrilinidae as belonging to the Anasca, where they have already been placed by Levinsen (1909, MSSB, p. 89), and to include in this Family those genera alone in which costae and lacunae can be definitely recognised.

Marcus (1922, AI, p. 427 n.), on the other hand, states that the Cribrilinidae do not belong to the Anasca, and that their assignment to the Ascophora is "richtig". He considers that the costae are secondary formations, resulting from pre-existing linear rows of pores, which have

1) See the criticisms of Waters, 1923, AMNH, 9, XII, pp. 546 et seq. and of Voigt, 1924, Pal. Zeitschr., VI, p. 110.

become connected with one another in such a way as to outline and differentiate them. According to my own view, the Cribrilinidae are a transitional group, and it is thus a matter for legitimate doubt whether they should be placed in the lower or the higher of the two groups which they connect. The fact, which is easily demonstrable, that in certain species the costae actually develop as spine-like structures growing from the margins of the frontal membrane, overarching it and finally uniting in the middle line, is a definite reason for regarding the costae themselves as the primary structures. LANG's studies on the Cretaceous Cribrimorphs furnish even more important Palaeontological evidence that evolution has actually taken place in this way. *Membraniporella* retains the primitive relations of the costae, as in certain Cretaceous species; and the lacunae are clearly uncalcified intervals between them. The lacunae of *Figularia fissa* (Pl. XXXIV, figs 22, 23) are perhaps secondarily enlarged, since other species of this genus have rows of small lacunae instead of the large single slits which characterise that species.

The study of *F. fissa* has suggested to me a new view of the mode of evolution of the frontal shield of a large proportion of the Ascophora, though not necessarily of all of them. I describe, under this species, a remarkable tendency for the increase of the gymnocyst at the expense of the frontal shield (figs 22—20). In extreme cases the costae have become vestigial, and the small lacunae may be no more than three in number, one median and two lateral. The compensation-sac, the space between the frontal shield and the frontal membrane, is not reduced *pari passu* with the costae, but extends beneath the gymnocyst nearly to the proximal end of the zooecium. It is but a short step from this condition to the Ascophora, in which the compensation-sac opens to the exterior by a single "median pore", as in the Microporellidae, or between the base of the operculum and the distal end of the frontal shield, as in most members of the group.

Although not in accordance with views I have previously expressed, I think the suggestion indicated above may be definitely put forward as one which removes many difficulties with respect to the Ascophora. These may be regarded as forms in which the costal area has practically disappeared, although one of its lacunae always remains as the opening of the compensation-sac, and costae are recognisable, in a vestigial form, in a certain number of genera and species. The frontal wall is then to be considered a gymnocyst, either imperforate as in *F. fissa* (Cribrilinidae), or with pores, which have no relation to lacunae, as in a large proportion of the group. This view is supported by the mode of development of the compensation-sac in certain Ascophora. Thus in *Euthyroides episcopalis* (Busk) (see HARMER, 1902, p. 280, Pl. XV, figs 13—17) the "lateral processes" (fig. 14, *l.p.*) can be regarded as a pair of costae (apertural bar), on the proximal side of which is the crescentic orifice of the compensation-sac, a "median pore" in the ordinary sense, and morphologically a lacuna. In the fertile zooecia of that species the Cribriline character is more definitely expressed, since there are about two pairs of typical costae, the arrangement being in fact remarkably similar to that found in forms of *Figularia fissa* (Pl. XXXIV, figs 20, 21) with a reduced costal area. The compensation-sac is first recognisable, at the base of the operculum, as a mass of undifferentiated cells (HARMER, 1902, fig. 13, *c.s.*) in which the cavity of the sac later appears. A similar mode of origin of the compensation-sac was described by me (pp. 297, 332) in "*Lepralia*" *pallasiana* and other species, the sac ultimately growing proximally so as to underlie the whole frontal surface.

Levinsen (1902, VMNFK, p. 4) considered that the compensation-sac, in "several forms" not specified, develops as an invagination (as I had suggested) at the proximal end of the operculum; and Ostroumoff (1903, Zool. Anz., XXVII, p. 96) published a short note in which he confirmed the view of a phylogenetic connexion between the compensation-sacs of *Cribrilina* and "*Lepralia*".

1. **Membraniporella** Smitt.

Membraniporella Smitt, 1873, KVAH, XI, 4, p. 10.
Membraniporella Hincks, 1877, AMNH, 4, XX, p. 526; — 1880, BMP, p. 199.
Membraniporella Waters, 1898, JLS, XXVI, pp. 661, 670.
Membraniporella Levinsen, 1909, MSSB, p. 158.
Membraniporella Canu and Bassler, 1920, USNMB, 106, p. 281.
Genotype, selected by Hincks, 1877, *Lepralia nitida* Johnston, 1838, HBZ, p. 277.

Zoarium usually encrusting. Zooecia with an unaltered frontal membrane, which is overarched by a varying number of costae, fusing with one another in the middle line, but usually with undivided lacunae. Paired avicularia may occur at the sides of the orifice. Ovicells hyperstomial. (Pore-chambers present; — Levinsen).

Membraniporella was instituted by Smitt for two species, *Lepralia nitida* (Johnston) and *M. agassizii* Smitt (1873, p. 11). Johnston regarded his species as the *Cellepora nitida* of Fabricius (1780, Fauna Groenl., p. 435). Whether this was correct or not, Hincks' genus was definitely based on *L. nitida* (Johnst.); and his selection of this species invalidates its acceptance as the genotype of *Lepralia*, as proposed by Norman (1903, AMNH, 7, XII, pp. 99, 100).

1. *Membraniporella aragoi* (Aud.). (Pl. XXXIV, figs 12—14).

Flustra aragoi Audouin, 1826, EPS, p. 240; — 1828, p. 68; — Savigny, DE, Pl. X, figs 1^1—1^3.
Flustra aragoi Hincks, 1880, BMP, p. 200; referred to *Membraniporella*.
Reptescharella aragoi D'Orbigny, 1852, PFTC, p. 465.
Membraniporella aragoi Waters, 1898, JLS, XXVI, p. 670.
Membranipora aragoi Waters, 1909, SRS, p. 167. Red Sea.

323. G. Stat. 50. Badjo Bay, W. Flores, 0—40 M.
447. B. Stat. 59. Samau Strait, W. Timor, 390 M.

Zoarium encrusting; zooecia in the main oval, but with a narrower proximal region formed by the gymnocyst. Frontal membrane and operculum completely Membraniporine. Opesia oval, its margins somewhat raised and bearing oral spines, one of which is distal and is followed by a pair at the sides of the operculum; the more proximal 4—5 pairs being costae, which interosculate and fuse to form a more or less developed frontal shield. Avicularia not found. Ovicell short, the ectooecium not reaching the oral arch, from which it is separated by a crescentic area; usually mucronate. Pore-chambers probably present.

The two specimens referred to this species require separate description.

323. G (figs 12, 13) is a colony in which all the zooecia are young, with translucent spines and costae. The lateral oral spines are suberect and commonly shortly bifurcate. The costae are narrow, their ends simple or bifurcate, and unite or interosculate in various ways

to form a narrow, median fused area; the lacunae correspondingly wide. In addition to the paired costae there may be a submedian proximal costa which usually unites with the others near the middle line. The ovicells have a short mucro (fig. 12), or a longer spine (fig. 13), or are without any median projection. In one or two zooecia the median fused part of the costae is broader than in fig. 12, and one or two minute lacunae may be seen between their interosculating branches.

447. B (fig. 14) is an old colony, much worn and with the costae broken off in most of the zooecia. When complete they are thick (the lacunae between them correspondingly narrow), opaque, white, and much more extensively fused than in the younger specimen, but agreeing with it in their number and in that of the oral spines. The costae are more branched than in 323. G and their fused part is Cribriline in appearance, almost as wide as the zooecium and with a moderate number of minute lacunae or pelmata between the unfused parts of the costae or on them. The ovicells are substantially as in 323. G, but without a mucro. In a few zooecia the lateral oral spines have the arrangement shown by Savigny (figs 1^2, 1^3), the spine expanding at its end, which is truncate, longitudinally directed and provided on its frontal surface with a series of small projections, exactly as figured by Savigny. The ends of the enlarged spines meet the frontal shield, on either side of the middle line, where the shield may have a small median projection, distally, into the secondary aperture.

From this peculiarity of some of the lateral oral spines, 447. B may be confidently referred to Audouin and Savigny's species; the figures of which show a condition of the frontal shield intermediate between the two Siboga specimens.

M. aragoi is much like *M. crassicosta* Hincks (1888, AMNH, 6, I, p. 216), from the St Lawrence; the resemblance and differences having already been pointed out by Hincks. It also appears to be allied to *M. magnifica* Thornely (1912, PIOS, p. 144, Pl. VIII, fig. 5), from the Indian Ocean (Cargados), but differs from it in not having the branched and distally directed oral spines described by that author.

2. **Colletosia** Jull.

Cribrilina (pars) auctt.
Colletosia Jullien, 1886, BSZF, XI, p. 610.
(?) *Pleuroschizella* Canu, 1919, BSGF, 4, XVIII, p. 303.
Genotype, *Lepralia endlicheri* Reuss (see below).

Costae separated by a row of small lacunae. Orifice semicircular, with oral spines. Avicularia vicarious or absent. Ovicells hyperstomial. Pore-chambers present.

There is considerable difficulty in deciding the genus to which *Cribrilina radiata* (auctt.), the commonest and most widely distributed of its Family, should be referred. Hincks (1877, AMNH, 4, XX, p. 526), in disregard of the Rules of Nomenclature, gave *Lepralia* [*Eschara*] *radiata* Moll as the genotype of *Cribrilina*, a monotypical genus introduced by Gray (1848, pp. 116, 147) for *Lepralia punctata* Hassall, which is therefore its genotype. Jullien (1886, p. 604) followed Hincks in this respect, but in the same paper (p. 610) he proposed *Colletosia*, with the genotype *Lepralia endlicheri* Reuss. He referred explicitly to Reuss, Pl. I, fig. 9 (1874, DAWW, XXXIII, p. 171), but the species had been previously described by Reuss in 1847

(FPWT, p. 82). Waters (1887, QJGS, XLIII, p. 53) regarded *C. endlicheri* as a variety of *C. radiata*, and it seems to be at least closely allied to *Lepralia innominata* auctt., (for which see Hincks, 1880, BMP, pp. 185, 187, Pl. XXV, figs 1, 2), a form which differs from the typical *C. radiata* in having fewer lacunae and more prominent costae, but is generally regarded as a variety of that species. Jullien's genus *Colletosia* may thus fairly be considered to include *C. radiata*; although in that case his diagnosis must be amended, as he defined it as having neither lacunae nor spines and stated that avicularia are unknown. *Puellina* Jullien (1886, p. 607), in which *C. radiata* has been placed by recent writers, was introduced with *Lepralia gattyae* (Busk) Landsborough (see Hincks, 1880, p. 198) as its genotype; and this species does not seem to be congeneric with *C. radiata*.

Waters (1923, AMNH, 9, XII, p. 548) has stated that *Castanopora* Lang (1916, AMNH, 8, XVIII, pp. 93, 94; — 1922, Cat. Cret. Bry. Brit. Mus., IV, pp. 158, 202), does not seem to differ generically from *C. radiata* and other recent Cribriline forms.

1. *Colletosia radiata* (Moll). (Pl. XXXIV, figs 15—18).

Eschara radiata Moll, 1803, Eschara, p. 63, Pl. IV, figs 17, A—I. Mediterranean.
Flustra pouilletii Audouin, 1826, EPS, p. 240; 1828, p. 68. Red Sea; — Savigny, DE, Pl. IX, figs 12^1—12^5.
Lepralia radiata Busk, 1858, QJMS, VI, pp. 128, 263, Pl. XX, figs 4, 5. Madeira.
Lepralia pouilletii Busk, 1859, QJMS, VII, p. 66, Pl. XXII, fig. 6. Madeira.
Cribrilina radiata Smitt, 1873, KVAH, XI, 4, p. 22, Pl. V, figs 107, 108. Florida.
Cribrilina radiata Hincks, 1880, BMP, p. 185, Pl. XXV, figs 3—9. Synonymy and variation.
Cribrilina radiata Jullien, 1881, BSZF, VI, p. 205. Étretat, Cape Verde Is, Singapore.
Cribrilina radiata Waters, 1882, QJGS, XXXVIII, p. 265. Eocene to Postpliocene; — (var.) 1885, JRMS, 2, V, p. 777, Pl. XIV, fig. 34 (mandible, Naples); — 1913, BEA, p. 501. Zanzibar; — 1918, JLS, XXXIV, p. 10. Cape Verde Is.
Cribrilina radiata MacGillivray, 1889, PZV, XIX, p. 317, Pl. 187, figs 3, 4. Victoria; — 1895, TRSV, IV, p. 58, Pl. VIII, fig. 9. Tertiary, Victoria.
Cribrilina radiata Kirkpatrick, 1890, AMNH, 6, V, p. 16. China Sea; — 1890, TS, p. 612. Torres Straits.
Cribrilina radiata (var. *β* Hincks), Philipps, 1899, WZR, pp. 440, 443. Loyalty Is.
Cribrilina radiata de Angelis, 1899, Bol. real. Acad. Scienc. Barcelona, 3, I, N° 26, p. xxxv, Pl. B, fig. 10. Pliocene, Catalonia.
Cribrilina radiata Calvet, 1902, TIZM 2, N° 12, p. 14. Corsica; — 1907, BTT, p. 398. Mediterranean, Morocco, Azores.
Cribrilina radiata Canu, 1904, Bry. Explor. Sci. Tunisie, Paléont., p. 19, Pl. XXXIV, fig. 23. Tertiary, Tunis.
Cribrilina radiata Thornely, 1905, PGM, p. 112. Ceylon; — 1907, MPIM, p. 187. Burma, etc.; — 1912, PIOS, p. 144. Indian Ocean.
Cribrilina radiata Norman, 1909, JLS, XXX, p. 291. Madeira.
Cribrilina radiata Robertson, 1921, BBB, p. 52. Ceylon, Andamans, Laccadives, Bay of Bengal, Burma.
Cribrilina innominata Smitt, 1873, KVAH, XI, 4, p. 22, Pl. V, figs 109, 110. Florida.
Puellina radiata Faura Sans and Canu, 1916, BTTC, p. 79, text-fig. 5. Tertiary, Catalonia.
Puellina radiata Canu and Bassler, 1920, USNMB, 106, p. 295, Pl. XLI, figs 14—18. Synonymy.
Cribrilina radiata, var. *α*, *β* and *tenuirostris* Hincks, 1880, BMP, pp. 186, 187. — (var.), 1880, AMNH, 5, VI, p. 74, Pl. X, fig. 1. Madeira; — (var.), 1891, AMNH, 6, VIII, p. 87. Variability of avicularia.
Cribrilina radiata, var. *flabellifera* Kirkpatrick, 1888, AMNH, 6, I, p. 75, Pl. X, fig. 4. Mauritius.
Cribrilina radiata, var. *flabellifera* Thornely, 1912, PIOS, p. 144. Indian Ocean.

Cribrilina setosa Waters, 1899, JRMS, p. 8. Madeira, Naples (= var. *a*, Hincks, 1880, BMP, p. 186), nec *C. annulata*, var. *setosa* Kirkpatrick, 1890, AMNH, 6, V, p. 18, Pl. V, fig. 4. China Sea.
Puellina innominata, var. *vicariata* Waters, 1923, AMNH, 9, XII, p. 559, Pl. XVII, fig. 3. Singapore or Philippines.
Puellina innominata, var. *hincksii* Friedl; WATERS, t. cit., p. 560, Pl. XVIII, fig. 6. Madeira, Mediterranean, British and French coasts (= *C. radiata*, var. HINCKS, 1880, AMNH, 5, VI, p. 74).

17.G. Stat. 49a. Sapeh Strait, E., 69 M.
57.D. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M.
388.K. Stat. 81. Borneo Bank, Strait of Makassar, 34 M.
467. I. Stat. 91. Muaras Reef, E. Borneo, 0—54 M.
395.E. Stat. 162. Off Loslos Id, N. end of New Guinea, 18 M.
131.G. Stat. 164. W. of N. end of New Guinea, 32 M.
566.E. Stat. 204. Between Wowoni and Buton, S. E. Celebes, 75—94 M.
177.M. Stat. 257. Kei Is, 0—52 M.
247.D. 249.M. Stat. 310. Sumbawa, E., 73 M.

Cambridge, Mus. Zool.: —

Torres Straits, 36, A. C. HADDON, Reg. Feb. 24, 1898.
Ceylon, Miss L. R. THORNELY, Reg. Apr. 25, 1906, 24.
Japan, S. W., T. MITZOBUCHI, Reg. Feb. 1, 1901.
Tahiti, Miss E. C. JELLY, Reg. May 24, 1895.
Lifu, Loyalty Is, A. WILLEY Coll. (Miss E. G. PHILIPPS), Reg. Mar. 1, 1898.

Zoarium encrusting. Zooecia small, vitreous, separated by deep grooves, from which the surface rises gradually, forming a strongly convex frontal surface, or vertically at the commencement of the costae, which bend horizontally at an angle, forming a more flattened frontal shield. Orifice semicircular, small, the operculum well chitinised. Oral spines usually 6—7, long in the young state, generally reduced to their bases, arranged in a semicircle of vertical, parallel and closely approximated spines. Costae forming the apertural bar oblique, converging and uniting proximally, their distal part forming a suboral lip, their proximal part usually rising to a pointed mucro. A single median lacuna is generally found between the mucro and the orifice, but may be represented by several foramina, indicating unfused parts of the costae. The remaining costae are 5—12 on each side, often forming distinct ridges, beaded or even spinose on their frontal edges, and commonly with a short, erect, calcareous spine close to their origin. In the distal part of the zooecium the two costae of a pair may form a continuous, almost transverse ridge, but proximally they converge in a radial manner. The intercostal lines are occupied by a row of lacunae, which may be longer than wide. Chitinous papillae ("vibraculoid setae" of authors) rarely seen. Avicularia vicarious, very variable in form. The mandible is always acute, often greatly elongated and linear distally, occasionally with a widened hastate portion distally. Ovicells (fig. 15) small, vitreous and smooth, with a slight median carina. Ancestrula often visible, Tatiform. Pore-chambers present.

The synonymy of this widely distributed species might have been greatly enlarged, both in recent and fossil records. I have selected principally papers illustrating the distribution and structure of the species, and I have excluded descriptions referring to *C. innominata*, which WATERS in his latest paper on the subject (1923, AMNH, 9, XII, p. 556) regards as a possibly distinct species.

I have previously (1902, QJMS, XLVI, p. 326, Pl. XV, fig. 7) described and figured the ancestrula of this species, calling attention (p. 321) to its agreement with the "Tata form" of SMITT. This is a simple, Membraniporine zooecium, with a freely exposed frontal membrane surrounded by a series of marginal spines, the proximal one sometimes widened and scutiform. This type of ancestrula may be found unaltered even in moderately large colonies; and Siboga specimens agree with my earlier description, except that I have observed a scutiform proximal spine in one case only. The ancestrula is commonly found on one margin of the colony, the growth of which is flabellate, instead of becoming surrounded by zooecia, a condition which may also occur. Two or three of the earliest members of the colony are generally small, the remaining zooecia being considerably larger. A similar condition has been observed by WATERS (1924, AMNH, 9, XIV, Pl. XIX, fig. 5) in another species.

In the same paper I discussed the morphology of the costae, and I then came to the conclusion that the "vibraculoid setae" (which have none of the characteristics of vibracula) represent spines of the ancestrula. The "setae" occur on either side of the orifice, followed by similar, smaller structures of the same kind, one at the commencement of each row of lacunae of the frontal shield. On this view the lacunae were to be regarded as pelmata and were not comparable with those of other Cribrilinidae. NORMAN (1903, AMNH, 7, XII, p. 96) criticised my conclusion; and, although the specimens previously studied are not at present in my hands, I am prepared, from the examination of the Siboga material, to accept his correction. His figure (Pl. IX, fig. 3), which refers to *C. innominata*, may be regarded as convincing with regard to this point. I thus conclude that the "pores" are intercostal lacunae, and that the chitinous papillae do not represent ancestrula-spines, with which the costae really correspond, as in other Cribrilinidae. The small membranous papillae and the larger "vibraculoid setae" at the sides of the orifice are perhaps uncalcified spines, developed on pores of the zooecial wall.

The zooecia vary in the number of their costae, and to some extent in size, being occasionally of abnormal width proximally, as shown by SMITT (1873, Pl. V, fig. 107). The avicularia are even more variable, but I do not attach much importance to the varietal names which have been suggested on the characters of the rostra and mandibles. The avicularia are often clearly vicarious [1]) and may probably be regarded as typically of this nature. In some cases their base is so much reduced that they tend to assume the adventitious type, and perhaps do not always reach the base of the colony. Fig. 18 represents avicularia from two specimens found at the same locality, that on the right being the more usual type, with linear rostrum and mandible, as figured by HINCKS (1880, AMNH, 5, VI, Pl. X, fig. 1). The other mandible is narrow near its proximal end, then dilating into a broad, hastate expansion, the rostrum extending no further than the narrow part of the mandible (var. *flabellifera* Kirkp.). In other cases (fig. 17) the avicularium is larger and more obviously vicarious, its rostrum and mandible very long and linear (near var. *vicariata* Waters); or the rostrum and mandible are considerable stronger and more triangular. The mandible frequently extends beyond the rostrum.

A conspicuous median lacuna generally occurs on the proximal side of the orifice (fig. 16), often partly concealed by the mucro of the apertural bar. In other cases there is a group of

1) This opinion was expressed by JULLIEN (1881, p. 205) and by WATERS (1891, QJGS, XLVII, p. 16).

small lacunae, instead of a single larger one. These differences indicate varying amounts of fusion of the halves of the bar.

There has been much difference of opinion with regard to the question of *C. radiata* and *C. innominata*. NORMAN (1909, p. 291) admitted that the suboral lacuna is subject to great variation in both forms, although he had previously maintained that a single lacuna was characteristic of the latter. The Siboga specimens are distinctly of the *radiata* type, and I have not found any which specially resemble British forms of *C. innominata*.

It is of interest to notice that zooecia with broken frontal shields show a typical Membraniporine frontal membrane.

3. **Figularia** Jull.

Figularia Jullien, 1886, BSZF, XI, p. 608.
Figularia Canu and Bassler, 1920, USNMB, 106, p. 313.
Figulina (errorim) Norman, 1903, AMNH, 7, XII, p. 98.
Figulina (errorim) Levinsen, 1909, MSSB, p. 159.

Genotype, selected by JULLIEN, *Lepralia figularis* Johnston, 1847, HBZ, p. 314.

Frontal shield with well defined costae, usually with numerous fusions giving rise to a row of lacunae, occasionally without lateral fusions, the costae then separated by undivided slits. Orifice closed by a completely chitinised operculum, which articulates with lateral condyles. Oral spines usually wanting. Ovicells large, hyperstomial, the ectooecium generally with membranous fenestrae. Avicularia, when present, vicarious. Pore-chambers wanting. (Distal rosette-plates uniporous, lateral plates multiporous; — LEVINSEN).

The occurrence of certain features in *F. fissa* renders necessary an emendation of JULLIEN's diagnosis, according to which each intercostal space contains a row of pores, and a large pelma occurs near the commencement of each costa. JULLIEN's name has been frequently misquoted, as by NORMAN and LEVINSEN, who both give it as *Figulina*, and by Waters (1923, AMNH, 9, XII, p. 567), who uses this form and *Figularis*, as well as *Figularia*. WATERS here described three species as *Figulina* and a fourth as *Figularia* (pp. 567—571), and it is not obvious whether this was accidental or intentional.

1. *Figularia fissa* (Hincks). (Pl. XXXIV, figs 19—23).

Cribrilina figularis, var. *fissa* Hincks, 1880, BMP, pp. 196, 197, Pl. XXVI, fig. 8. Singapore.
Figulina figularis, f. *fissa* Marcus, 1922, AI, p. 427, Pl. XXIV, fig. 4. Aru Is.

38. N. Stat. 77. Borneo Bank, Strait of Makassar, 59 M.
135. E. Stat. 164. W. of N. end of New Guinea, 32 M.
249. A. Stat. 310. Sumbawa, E., 73 M.

Zoarium encrusting. Zooecia elongate, separated by shallow grooves, from which the calcareous frontal walls rise gradually and slightly. Gymnocyst considerably developed proximally, sometimes forming nearly the whole frontal wall. Frontal shield variable in length and in the number of costae which partake in its formation. The first pair of costae (apertural bar) are broader than the others and unite to form a sharply marked suboral border to the orifice. A lower lip may be indicated as the distal part of the apertural bar, from the rest of which it

is marked off by a shallow groove. The other costae, which vary in width, are usually 3—4 pairs, the frontal shield being then as long as wide, or longer. The shield may be greatly reduced, only three lacunae occurring in extreme cases; and it is then very short, the gymnocyst forming nearly the whole of the frontal surface. The costae fuse in the middle line, where one or more small lacunae may be found between unfused portions. The main lacunae between the costae are large and elongate, not interrupted by secondary fusions. No pelma occurs at the outer end of the costa, but one is found in the median fused area, at its distal end. Orifice with a broad, shallow sinus, with a pair of minute opercular condyles; without oral spines. Operculum subcircular, with a sclerite at or close to its margin. Avicularia vicarious, variable in size, sometimes almost as large as a zooecium, in other cases very much smaller; the calcareous bar complete and strong. Rostrum with two convex lobes proximally, then expanding to the distal end, which is semicircular or trifoliate, in the latter case with 4 strong erect cusps. Mandible (fig. 19) varying with the rostrum, triangular at its base, then narrower and either spoon-shaped or trifoliate distally, where it is much wider. Ovicells large, projecting deeply into the succeeding zooecium, subcarinate in the middle line, with a pair of long, lateral, curved fenestrae ("pyriform fossae"), where the ectooecium remains membranous. The apertural bar of the fertile zooecia is compressed, its frontal edges standing up vertically beyond the level of the remaining costae; and the distal pelma of each half is distinct.

Hincks regarded *F. fissa* as a variety of *F. figularis* (Johnst.). Although described in his well known work on the British Polyzoa, the locality of the "variety" was given as Singapore. It seems to have remained almost unnoticed, though Waters (1885, QJGS, XLI, p. 293) refers to it in connexion with a fossil from South Australia. I have discussed the conclusions of Marcus with regard to this species under the Family, and I have little doubt that it deserves specific rank. *F. figularis* is characterised by having a well marked row of small lacunae in each intercostal space, and there is a conspicuous pelma near the proximal end of each costa. These features have been described by various authors, but it will be sufficient to cite Hincks (1880, BMP, p. 196, XXVI, figs 5—7). In *F. fissa*, on the contrary, the costae are separated by a single large lacuna, which is not subdivided, and there is no proximal pelma. In the reduced frontal shield of some specimens this species resembles *Membraniporella magellanica* Calvet (1904, HMS, p. 15, Pl. I, figs 4 *a*, *b*), from the Magellan Region, and *Cribrilina patagonica* Waters (1905, JLS, XXIX, p. 236, Pl. XXVIII, figs 6, 7), from the same neighbourhood. These species and *C. biporosa* Okada (1923, AZJ, X, p. 226, Plate, fig. 6) should probably be placed in *Figularia*.

This very handsome species shows one or two well marked variations, which may occur in the same zoarium. In 249. A the frontal shield is relatively long, with 3—4 pairs of costae in addition to the apertural bar (figs 22, 23). Even in this colony a few zooecia have the reduced frontal shield which occurs in the next specimen. In 38. N (figs 20, 21) some zooecia have the normal frontal shield, but many of them have this part greatly reduced, the costae being sometimes represented by no more than a single pair, in addition to the apertural bar. Zooecia in this condition have almost lost the Cribriline character, and nearly the whole frontal wall consists of a smooth imperforate gymnocyst.

The avicularia, which are always vicarious, are similarly variable, within the limits of

a single colony. They vary in respect of size (figs 22, 23, both from the same colony), and in the shape of the distal end of the rostrum, in which cusps may be present or wanting. WATERS (1889, AMNH, 6, IV, Pl. I, fig. 8) has figured, in *F. clithridiata*, a trifoliate mandible resembling some of those found in *F. fissa*. The principal avicularian muscles consist of strong occlusors formed of a group of fibres originating from the distal wall and from the distal parts of the lateral walls, close to their junction with the basal wall; and of a second strong group, horseshoe-shaped, with distal concavity, originating from the basal wall of the proximal part of the avicularium. The divaricators are a delicate row of fibres inserted into the proximal part of the frontal membrane in a semicircle of which the chord is formed by the base of the mandible, the line of insertion being at some distance from the outer border of this part of the frontal membrane.

The opercular occlusors originate from the basal wall, at its distal end. Parietal muscles occur along nearly the whole length of the compensation-sac, which extends more proximally than the frontal shield. They correspond in arrangement with those previously described by me (1902, QJMS, XLVI, p. 293, Pl. XV, fig. 9), in *F. philomela* (Busk), in which I observed the occasional presence of a polypide in a vicarious avicularium.

In some zooecia I have found a pair of sausage-like bodies, usually unequal in size, passing by a fine line, probably a duct, to the vestibule, into which they apparently open. These are the "testicules" observed by JULLIEN (1888, Mém. Soc. Zool. France, I, p. 270) in *F. figularis*, and the "opercular glands" described, in various Cheilostomes, by WATERS (1913, BEA, p. 487, Pl. LXXI, figs 8, 9, and in many other places). JULLIEN's view that these structures are testes may be correct, but this conclusion does not seem to have been confirmed. If it is not correct, possible alternatives which suggest themselves are that these organs may be excretory, that they may secrete a poisonous substance serving as a protection against enemies, or that they may function like the endostyle of Tunicates in producing a secretion which entangles food-particles.

The rosette-plates agree with the generic diagnosis, as given by LEVINSEN.

F. fissa is of great interest in perhaps elucidating the evolution of the Ascophorous Cheilostomes, a question I have discussed above, under its Family.

I wish to make a special acknowledgment of the invaluable assistance I have received from two of my colleagues. Mr R. KIRKPATRICK has repeatedly helped me by finding the specimens, in the British Museum, to which it was necessary for me to refer, by verifying their register-numbers, by discussing with me which are the types of their respective species and in many other ways. Mr C. DAVIES SHERBORN has done an inestimable service to Zoology by the publication of his "Index Animalium", Sect. 1 (1758—1800) and by the preparation of his invaluable MS. index, now in course of publication as Sect. 2 (1801—1850) of the same work. This index and his unequalled knowledge of the Bibliography of Zoology have for many years been freely placed at the disposal of all who wished to consult him, and I am indebted to him for much help in ascertaining what names are pre-occupied and in arriving at conclusions with regard to difficult points of nomenclature.

S. F. H.

E. BIBLIOGRAPHY.

The method of using this Bibliography, in which full references are given to most of the memoirs which have a special connexion with the subject of the Report, is explained on p. 186. The full titles of the current journals, here given in a contracted form, may be found in "A World List of Scientific Periodicals published in the Years 1900—1921" (London, 1925). The number employed in that work is quoted, in each case, at the end of the shortened reference.

ABAW — Abhandl. K. Bayerisch. Akad. Wiss., Math.-Phys. Kl., München. — 23.

AHMW — Ann. K. K. Naturhist. Hofmus. Wien. — 795.

AJSA — Amer. Journ. Sci. Arts, New Haven. — 621.

AMNBA — Anal. Mus. Nac. Hist. Nat. Buenos Aires. — 736.

AMNH — Ann. Mag. Nat. Hist., London. — 1050.

ANG — Arch. f. Naturgesch., Berlin. — 1782.

AP — Ann. de Paléontol., Paris. — 899.

ASNG — Abhandl. Senckenberg. Naturf. Ges., Frankfurt a. M. — 69.

ASNM — Atti Soc. Nat. e Mat. Modena. — 2192.

ASNZ — Ann. Sci. Nat. (Zool.), Paris. — 915.

AUDOUIN, 1826, EPS — Audouin, J. V. "Explication sommaire des Planches de Polypes de l'Égypte et de la Syrie", in "Description de l'Égypte", "Hist. Nat.", I, Pt 4, p. 225. See SAVIGNY.

—— 1828, EPS — Audouin, J. V., Ibid., Éd. 2., XXIII, p. 40.

AZEG — Arch. Zool. Exp. et Gén., Paris. — 1915.

AZIW — Arb. Zool. Inst. Wien. — 1683.

AZJ — Annot. Zool. Japon., Tokyo. — 1072.

BAAS — Rep. Brit. Ass. Adv. Sci., London. — 17977.

BARB — Bull. Acad. Roy. Belg., Bruxelles. — 3690.

BBF — Bull. Bur. Fish., Washington. — 3938.

BLAINVILLE, 1830, DSN — Blainville, H. M. D. de, in Dict. Sci. Nat., LX, Paris.

—— 1834, MA — Blainville, H. M. D. de, "Manuel d'Actinologie ou de Zoophytologie", Paris.

BMA — Bergens Mus. Aarbog. — 2583.

BMCZH — Bull. Mus. Comp. Zoöl. Harvard, Cambridge, Mass. — 4604.

BMHN — Bull. Mus. Hist. Nat., Paris. — 4605.

BOSC, 1802, HNV — Bosc, L. A. G., "Histoire Naturelle des Vers", III, Paris.

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BSBG — Bull. Soc. Belge Géol. Paléont. et Hydrol., Bruxelles. — 4988.

BSEHN — Bol. R. Soc. Esp. Hist. Nat., Madrid. — 3232.

BSGF — Bull. Soc. Géol. France, Paris. — 5127.

BSZF — Bull. Soc. Zool. France, Paris. — 5401.

BUSK, 1852, VR — Busk, G., "An Account of the Polyzoa and Sertularian Zoophytes, collected in the Voyage of the Rattlesnake, on the Coasts of Australia and the Louisiade Archipelago", App. to J. MacGillivray's "Narrative of the Voyage of H. M. S. Rattlesnake 1846—1850", Vol. I, pp. 343—385. London.

—— 1852, BMC — Busk, G., Catalogue of Marine Polyzoa in the British Museum, Part I. London.

—— 1854, BMC — Busk, G., Ibid., Part II. London.

—— 1857, CMM — Busk, G., "Bryozoa", in P. P. Carpenter, "Catalogue of Mazatlan Shells in the British Museum". London.

—— 1859, FPC — Busk, G., "A Monograph of the Fossil Polyzoa of the Crag", Palaeont. Soc. London.

—— 1884, Chall. — Busk, G., "Report on the Polyzoa". "The Cheilostomata", Challenger Reports, Vol. X, Pt XXX.

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—— 1907, BTT — Calvet, L., "Bryozoaires", Expéd. Sci. 'Travailleur' et 'Talisman' 1880—1883, VIII, p. 355.

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CIW — Publ. Carnegie Inst. Washington. — 17340.

DAWW — Denkschr. K. Akad. Wiss., Math.-Nat. Kl., Wien. — 7134.

D'ORBIGNY — See under O.

ELLIS, 1755, NHC — Ellis, J., "An Essay towards a Natural History of the Corallines". London.

—— and SOLANDER, 1786, NHZ — Ellis, J. and Solander, D., "The Natural History of Zoophytes". London.

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FISI — Dep. Agricult. and Techn. Instr. Ireland, Fish. Branch, Sci. Invest., Dublin. — 19978.

FLEMING, 1828, BA — Fleming, J., "A History of British Animals". Edinburgh.

FVSC — Forh. Vid. Selskab. Christiania. — 8604.

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GM — Geological Magazine, London. — 9060.

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JLS — Journ. Linn. Soc. (Zool.), London. — 11296.

JMSV — Journ. Micr. Soc. Vict., Melbourne. — 11361.

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KNVSS — K. Norsk. Vid. Selsk. Skr., Trondhjem. — 11863.

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KVAF — Öfv. K. Vet.-Akad. Förh., Stockholm.

KVAH — K. Svensk. Vet.-Akad. Handl., Stockholm. — 11870.

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MIM — Mem. Indian Mus., Calcutta. — 13401.

MSNM — Mém. Soc. Sci. Nat. Maroc, Rabat, Paris and London. — 13333.

MZSN — Mitt. Zool. Stat. Neapel, Berlin. — 14246.

NAMHN — Nouv. Arch. Mus. Hist. Nat., Paris. — 15316.

NHR — Nat. Hist. Review, Dublin.

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ODVSF — Overs. K. Danske Vid. Selsk. Forh. Copenhagen. — 15881.

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pp. 1—188. 1851. pp. 189—472. 1852. pp. 473—984. 1853. pp. 985—1192. 1854.

PAL. — Palaeontographica. Stuttgart. — 15933.

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PBSL — Proc. Liverpool. Biol. Soc. — 16792.

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PLPSL — Proc. Lit. Phil. Soc. Liverpool. — 16791.

PLSNSW — Proc. Linn. Soc. New South Wales. Sydney.

PPRST — Papers and Proc. Roy. Soc. Tasmania. Hobart. — 16010.

PRSV — Royal Society of Victoria. Vols I—V, 1854—1860, as "Transactions", Vols VI—XXIV, 1861—1887, as "Transactions and Proceedings"; New Series, Vols I— , 1888— , as "Proceedings". Melbourne. — 16904.

PTRS — Phil. Trans. Roy. Soc., London. — 16192.

PUSNM — Proc. U. S. Nat. Mus., Washington. — 16944.

PZS — Proc. Zool. Soc. London. — 16737.

QJGS — Quart. Journ. Geol. Soc., London. — 17504.

QJMS — Quart. Journ. Micr. Sci., London. — 17510.

QJMSV — Quart. Journ. Micr. Soc. Victoria, Melbourne.

RAM — Rec. Austral. Mus., Sydney. — 17736.

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SAWW — Sitzb. K. Akad. Wiss. Wien, Math.-Naturw. Kl. — 20170.

SGNFB — Sitzb. Ges. Naturf. Freunde Berlin. — 20189.

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SMC — Smithson. Misc. Coll., Washington. — 20256.

SMCQ — Smithson. Misc. Coll., Quarterly Issue, Washington.

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TCAAS — Trans. Connecticut Acad. Arts and Sci., New Haven. — 21469.

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TIZM — Trav. Inst. Zool. Univ. Montpellier. — 21732.

TMCNM — Trab. Mus. Cienc. Nat. (Zoológica), Madrid. — 21347.

TMGS — Trans. Manchester Geol. Soc.

TMS — Trans. Micr. Soc., London.

TPIV — Trans. Phil. Inst. Victoria, Melbourne.

TRSSA — Trans. Roy. Soc. S. Australia, Adelaide. — 21654.

TRSV — Trans. R. Soc. Victoria, Melbourne. — 21655.

TZS — Trans. Zool. Soc. London. — 21702.

USNMB — Bull. U. S. Nat. Mus., Washington. — 5659.

UUA — Upsala Univ. Årsskr., Math. och Naturw. — 22141.

VDZG — Verh. Deutsch. Zool. Ges., Leipzig. — 22270.

VMNFK — Vid. Medd. Naturh. Foren. Kjöbenhavn. — 22535.

VZBGW — Verh. K. K. Zool.-Bot. Ges. Wien. — 22327.

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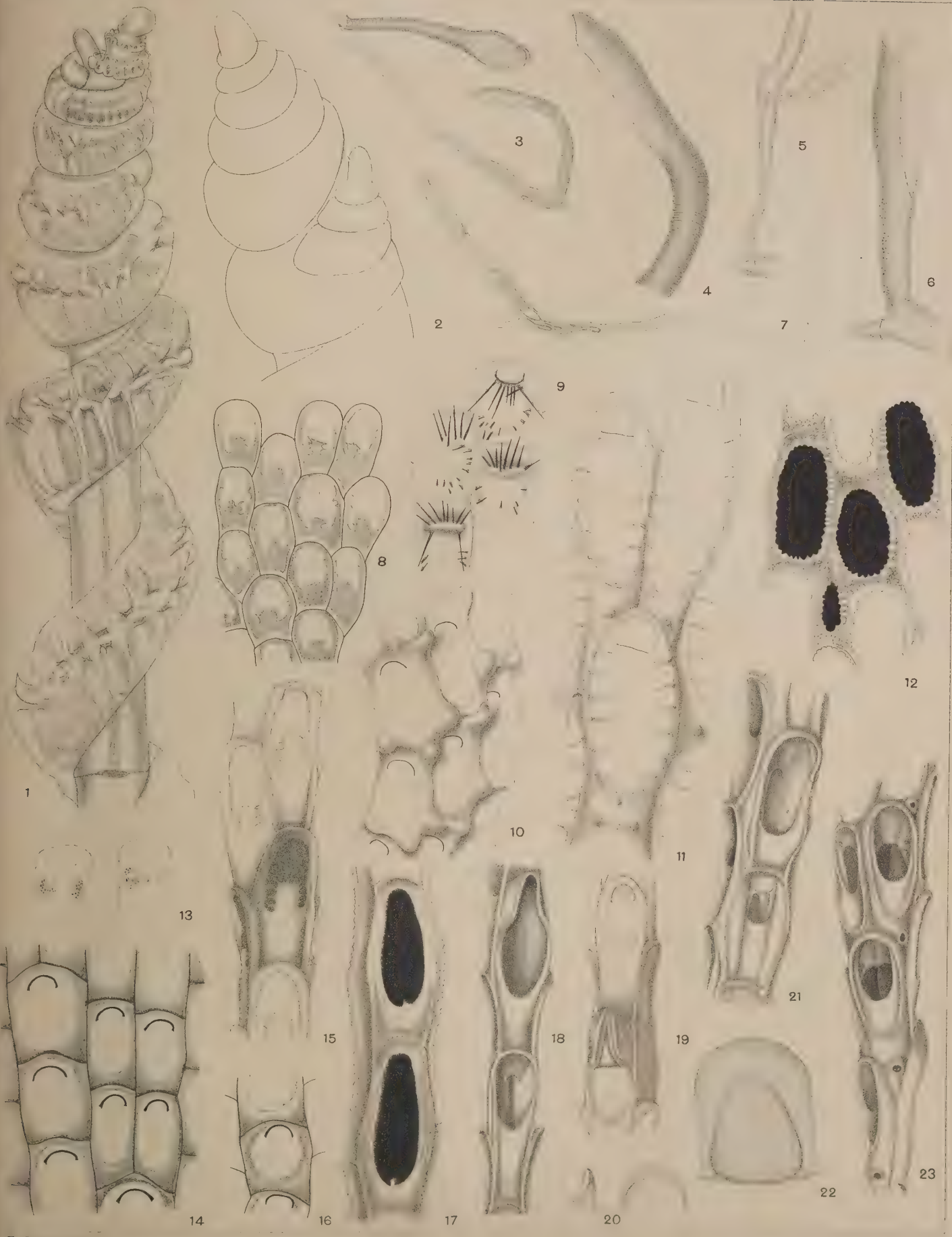
With a few exceptions, the figures were drawn with a Zeiss A or C Objective. Plates XVII, XXIX and XXX were reduced to $^1/_2$ the linear dimensions of the original drawings, and the remaining Plates to $^1/_3$. The scales, correspondingly reduced, are given at the foot of each Plate.

PLATE XIII.

CTENOSTOMATA (*Amathia*).
AETEIDAE (*Aetea*).
MEMBRANIPORIDAE (*Electra, Nichtina, Conopeum, Acanthodesia*).

Fig. 1. *Amathia vermetiformis* n. sp. (p. 183). — 598. B^1, Stat. 162. Tip of a growing stem. Obj. A.
Fig. 2. „ „ „ „ — Same slide. Tip of another stem, the branch somewhat older. Obj. A.
Fig. 3. *Aetea anguina* (L.) (p. 194). — 491. B, Stat. 145. Two zooecia (on *Catenaria* slide, 491. A^1). Obj. A.
Fig. 4. „ „ „ „ — One of the same zooecia, more highly magnified. Obj. C.
Fig. 5. *Aetea truncata* (Landsb.) (p. 196). — 117. E^2, Stat. 164. Part of a zooecium, showing jointed appendages. Obj. A.
Fig. 6. „ „ „ „ — The right zooecium of fig. 7, more highly magnified. Obj. C.
Fig. 7. „ „ „ „ — 117. E^2, Stat. 164. Two zooecia, one showing the polypide retracted into the adherent part. Obj. A.
Fig. 8. *Acanthodesia savartii* (Aud.) (p. 213). — 396. M^1, Stat. 162. Zooecia with proximal denticulate processes. Obj. A.
Fig. 9. *Conopeum eriophorum* (Lamx) (p. 212). — 132. A^1, Stat. 164. Zooecia. The uppermost operculum is widely open, and its spines are reflexed. Obj. A.
Fig. 10. *Nichtina tuberculata* (Bosc) (p. 208). — 363. A^1, Stat. 71. Zooecia. Obj. A.
Fig. 11. *Electra angulata* Levins. (p. 207). — 257. A^1, Stat. 312. Zooecia. Obj. A.
Fig. 12. *Conopeum reticulum* (L.) (p. 211). — 405. A^1, Stat. 258. Zooecia. Obj. A.
Fig. 13. *Acanthodesia savartii* (Aud.) (p. 313). — 308. A^2, Stat. 273. Distal rosette-plates of two zooecia, the basal edges below. Obj. A.
Fig. 14. „ „ „ „ — 308. A^1, same Station. Zooecia. Obj. A.
Fig. 15. *Acanthodesia savartii*, var. *cetrata* nov. (p. 216). — 555. D^2, Stat. 320. Zooecia. Obj. A.
Fig. 16. *Acanthodesia savartii* (Aud.) (p. 213) — 316. A^1, Stat. 273. Zooecia. Obj. A.
Fig. 17. *Acanthodesia limosa* (Waters) (p. 217). — 431. A^2, Stat. 2. Part of an internode, the zooecia of the left lateral row separated from the others by the action of Eau de Javelle. Obj. A.
Fig. 18. *Acanthodesia arctata* n. sp. (p. 219). — 158. A^1, Stat. 221. Internode with vicarious avicularium, above. Obj. A.
Fig. 19. „ „ „ „ — Same slide. Zooecia with chitinous parts. Obj. A.
Fig. 20. *Acanthodesia nelliiformis* n. sp. (p. 218). — 4. B^4, Stat. 12. Opercula. Obj. C.
Fig. 21. „ „ „ „ — 4. B^3, same Station. Internode with a large vicarious avicularium. Obj. A.
Fig. 22. „ „ „ „ — 4. B^4, same Station. Mandible of vicarious avicularium. Obj. C.
Fig. 23. *Acanthodesia simplex* (Busk) (p. 220). — Torres Straits, 226 (not Siboga Coll.). Part of an internode. Obj. A.



S. F. Harmer del. Fa. P. W. M. Trap impr.

PLATE XIV.

MEMBRANIPORIDAE.

(*Caleschara, Crassimarginatella, Allantopora, Pyrulella, Copidozoum, Ellisina, Chaperia, Antropora, Nellia, Foveolaria*).

Fig. 1. *Caleschara levinseni* n. sp. (p. 221). — 404. B, Stat. 257. Zooecia, one with an ovicell. Obj. A.

Fig. 2. *Crassimarginatella spatulifera* n. sp. (p. 223). — 249. E^4, Stat. 310. Zooecia, with one vicarious avicularium and four vestigial ovicells. Obj. A.

Fig. 3. „ „ „ „ — 249. E^3, same Station. Mandible of vicarious avicularium. Obj. C.

Fig. 4. *Pyrulella corbula* (Hincks) (p. 225). — Torres Straits, 187^1, 129 (not Siboga Coll.). Showing one vicarious avicularium (below) and two ovicells (R., L.). Obj. A.

Fig. 5. *Allantopora translucens* n. sp. (p. 225). — 566. D^1, Stat. 204. Zooecia and ovicells. Obj. A.

Fig. 6. *Copidozoum sagittiferum* n. sp. (p. 227). — 250. D^1, Stat. 310. Zooecia, ovicell and vicarious avicularia. Obj. A.

Fig. 7. *Ellisina curvirostris* (Hincks) (p. 228). — Singapore, Hanitsch Coll. (not Siboga Coll.). Zooecia, ovicells and avicularium. Obj. A.

Fig. 8. *Chaperia cervicornis* (Busk) (p. 230). — Torres Straits, 160 (not Siboga Coll.). Two fragments, the right one cleaned, with two ovicells. Obj. A.

Fig. 9. *Chaperia acanthina* (Lamx) (p. 229). — 472. L, Stat. 99. Cleaned with Eau de Javelle. Obj. A.

Fig. 10. „ „ „ „ — Same slide, not cleaned. Obj. A.

Fig. 11. *Antropora granulifera* (Hincks) (p. 232). — 393. B^1, Stat. 133. Uppermost zooecium with an ovicell. Obj. A.

Fig. 12. „ „ „ „ — 412. E^2, Stat. 310. Mandible of vicarious avicularium. Obj. C.

Fig. 13. „ „ „ „ — 459. Q, Stat. 81. Avicularia partly transverse and partly longitudinal. Obj. A.

Fig. 14. „ „ „ „ — 388. L, Stat. 81. Young state, with a vicarious avicularium (L.). Obj. A.

Fig. 15. *Antropora marginella* (Hincks) (p. 234). — 459. P, Stat. 81. With numerous adventitious avicularia and one vicarious avicularium. Obj. A.

Fig. 16. *Nellia tenuis* n. sp. (p. 245). — 487. B^2, Stat. 129. Avicularium. Obj. C.

Fig. 17. „ „ „ „ — Same slide. Part of an internode. Obj. A.

Fig. 18. *Nellia oculata* Busk, typical form (pp. 240, 242). — 38. A^1, Stat. 77. Obj. A.

Fig. 19. *Nellia oculata*, var. *quadrilatera* D'Orb. (pp. 241, 242). — 416. B, Stat. 321. Without ovicells. Obj. A.

Fig. 20. „ „ „ „ „ „ — Same slide. With ovicells. Obj. A.

Fig. 21. *Foveolaria retiformis* n. sp. (p. 247). — 79. A, Stat. 105. Mandible. Obj. C.

Fig. 22. „ „ „ „ — Same slide. Operculum. Obj. C.

Fig. 23. „ „ „ „ — Same slide. Zooecia with one ovicell, avicularia and a marginal rootlet. Obj. A.

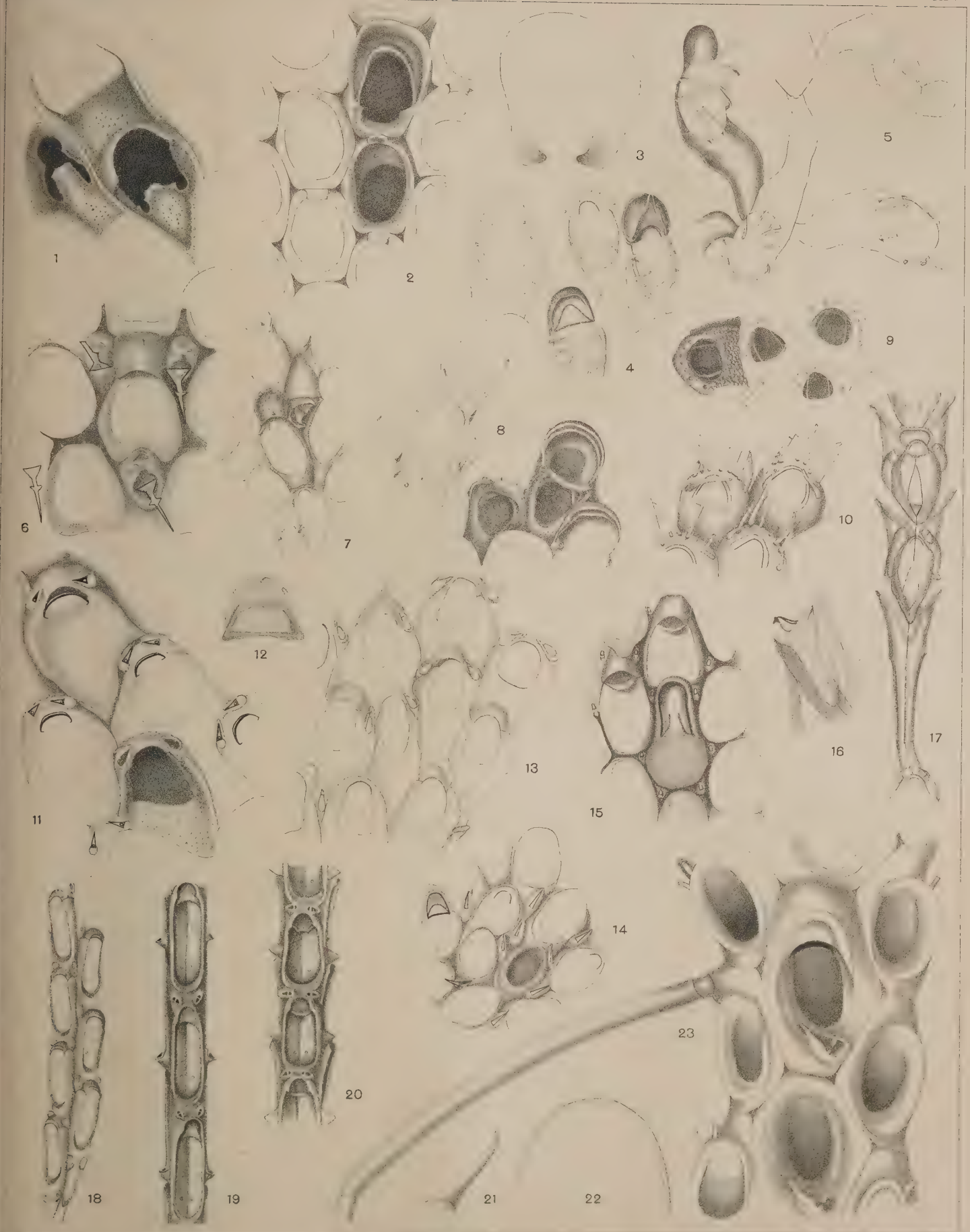


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PLATE XV.

FLUSTRIDAE (*Carbasea, Retiflustra*).
CHLIDONIIDAE (*Chlidonia, Crepis*).

Fig. 1. *Retiflustra reticulum* (Hincks) (p. 254). — 125. A, Stat. 164. Zooecia and ovicell. Obj. A.
Fig. 2. *Retiflustra schönaui* Levins. (p. 252). — 39. A^1, Stat. 77. Zooecia, two with vestigial ovicells and vicarious avicularium. Obj. A.
Fig. 3. *Retiflustra cornea* (Busk) (p. 250). — 194. A, Stat. 274. Zooecium and ovicell. Obj. A.
Fig. 4. *Retiflustra reticulum* (Hincks) (p. 254). — 259. B^2, Stat. 318. Zooecia, ovicell and vicarious avicularium. Obj. A.
Fig. 5. *Carbasea linguiformis* n. sp. (p. 249). — 498. A, Stat. 159. Zooecia and ovicell: *cr.*, cryptocyst. Obj. A.
Fig. 6. *Crepis decussata* n. sp. (p. 320). — 162. A^3, Stat. 227. Erect form. Avicularium, frontal view. Not drawn with camera lucida.
Fig. 7. „ „ „ „ — 162. A^2, same Station. Erect form. Part of internode, with two vicarious avicularia. Obj. A.
Fig. 8. „ „ „ „ — Same slide. Avicularium, more magnified. Obj. C.
Fig. 9. „ „ „ „ — 155. B, Stat. 211. Repent form, commencement of colony. Not drawn with camera lucida.
Fig. 10. *Chlidonia pyriformis* (Bert.) (p. 316). — 612. A^2, Stat. 163. Two zooecia, the lower one containing an egg or embryo, side view. Obj. C.
Fig. 11. „ „ „ „ — 501. B^1, Stat. 163. Distal end of stem, with four zooecia. Obj. C.
Fig. 12. *Crepis decussata* n. sp. (p. 320). — 155. B, Stat. 211. Repent form. Three zooecia, one with a rootlet. Obj. A.
Fig. 13. *Crepis verticillata* n. sp. (p. 319) — Torres Straits, 141^3 (not Siboga Coll.). Zooecia. Obj. C.
Fig. 14. „ „ „ „ — Same material, 141^1. Basal view of three zooecia. Obj. C.
Fig. 15. „ „ „ „ — Same slide. Portions of two stems, with whorls of zooecia. Obj. A.
Fig. 16. „ „ „ „ — Same slide. Zooecium with frontal membrane not much inclined. Obj. C.
Fig. 17. „ „ „ „ — Same slide, Zooecium with oblique frontal membrane. Obj. C.
Fig. 18. „ „ „ „ — Same slide as fig. 13. Zooecium with vertical frontal membrane. Obj. C.
Fig. 19. *Crepis longipes* Jull. (p. 318). — Singapore, R. Hanitsch (not Siboga Coll.). Zooecia. Obj. A.

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PLATE XVI.

LUNULARIIDAE (*Setosellina, Cupuladria*).
ONYCHOCELLIDAE (*Onychocella, Smittipora*).
STEGANOPORELLIDAE (*Steganoporella*).
CELLARIIDAE (*Atelestozoum*).

Fig. 1. *Setosellina constricta* n. sp. (p. 264). — 40. E, Stat. 77. Zooecia and vibracula. Obj. A.
Fig. 2. *Setosellina coronata* (Hincks) (p. 265). — 88. D^1, Stat. 115. Young zooecium and vibraculum (to the left), in oblique side view, to show the pore-chambers. Obj. A.
Fig. 3. " " " " — Same slide, showing the chitinous parts. Obj. A.
Fig. 4. " " " " — 88. D^2, same Station. Seta of vibraculum. Obj. C.
Fig. 5. *Cupuladria guineensis* (Busk) (p. 266). — 488. A^1, Stat. 133. Zooecia and vibracula. Obj. A.
Fig. 6. " " " " — 488. A^3, same Station. Operculum. Obj. C.
Fig. 7. " " " " — Same slide. Seta of vibraculum. Obj. C.
Fig. 8. *Onychocella angulosa* (Reuss) (p. 256). — 390. D^1, Stat. 99. Zooecia, with two ovicells (left) and avicularium. Obj. A.
Fig. 9. " " " " — 390. D^2, same Station. Mandible. Obj. C.
Fig. 10. *Smittipora abyssicola* (Smitt) (p. 259). — 409. B^1, Stat. 60. Zooecia with two ovicells, and two avicularia. Obj. A.
Fig. 11. " " " " — 420. B, Stat. 71. Zooecia, ovicell and three avicularia. Obj. A.
Fig. 12. " " " " — 409. B^2, Stat. 60. Mandible. Obj. C.
Fig. 13. " " " " — Same slide. Operculum. Obj. C.
Fig. 14. *Smittipora cordiformis* n. sp. (p. 260). — 323. H, Stat. 50. Zooecia, ovicell and avicularium. Obj. A.
Fig. 15. " " " " — 364. C^1, Stat. 71. Zooecia and two ovicells. Obj. A.
Fig. 16. " " " " — 323. H, Stat. 50. Zooecia and avicularium, with chitinous parts. Obj. A.
Fig. 17. " " " " — 364. C^3, Stat. 71. Mandible. Obj. C.
Fig. 18. " " " " — Same slide. Operculum. Obj. C.
Fig. 19. *Steganoporella dilatata* n. sp. (p. 275). — 413. A^2, Stat. 315. Three zooecia and avicularium. Obj. a^3 (Greenough).
Fig. 20. *Steganoporella mandibulata* n. sp. (p. 279). — 394. A^2, Stat. 144. Zooecia and avicularia. Obj. A.
Fig. 21. *Atelestozoum obliquum* n. sp. (p. 345). — 526. E, Stat. 211. 6th and 7th whorls of zooecia (see text). Obj. A.

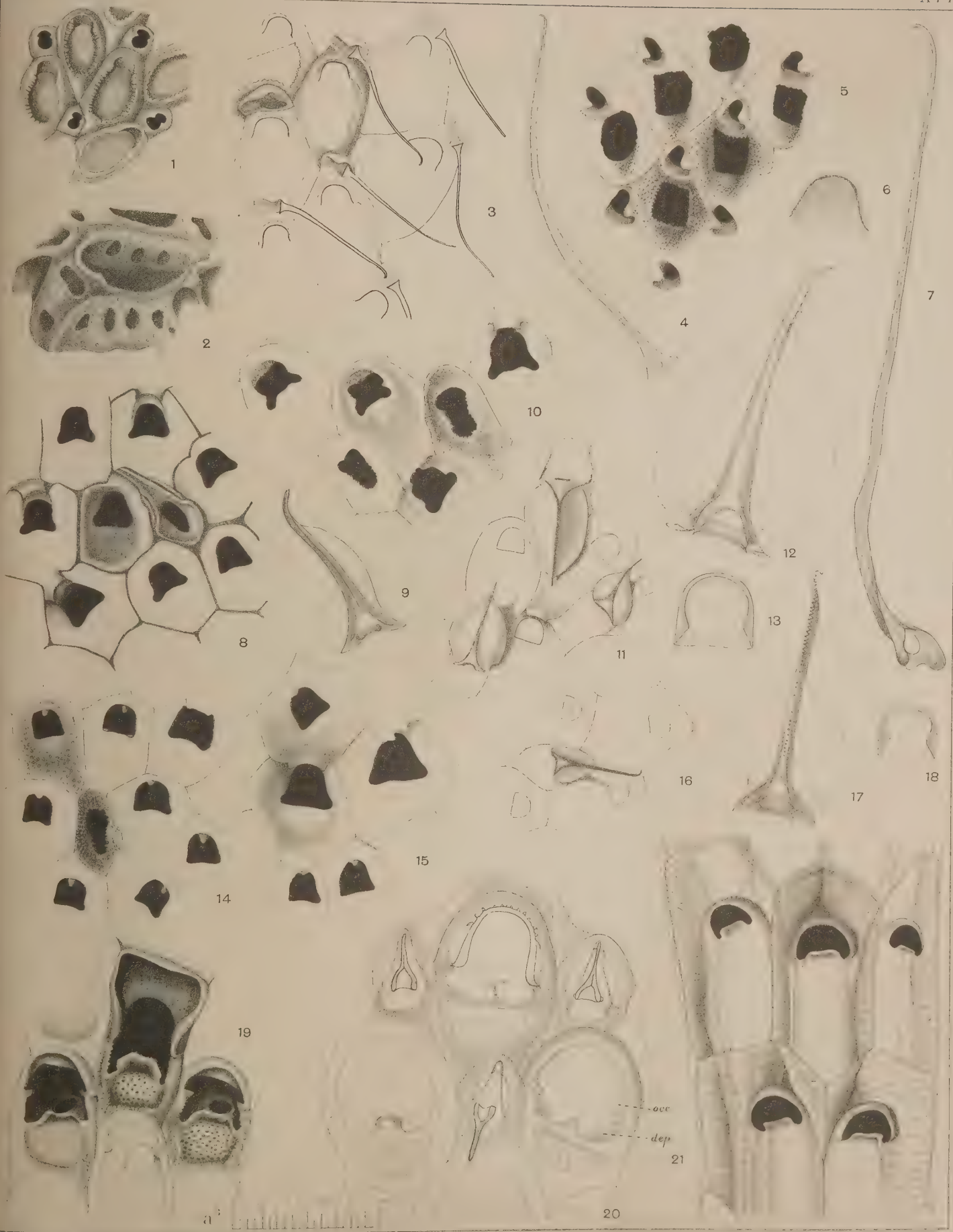

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PLATE XVII.

STEGANOPORELLIDAE (*Steganoporella*).
PORICELLARIIDAE (*Poricellaria*).

The specimens illustrating the anatomy of *Steganoporella* (pp. 270—273) were prepared by the methods described in my earlier papers (1900, QJMS, XLIII, p, 240; — 1902, ibid., XLVI, p. 265).

al. c., alimentary canal.
b. s., basal sclerite, of operculum or mandible.
d., diaphragm.
d. c., descending cryptocyst, or its insertion into the basal wall.
dep., depressor muscle.
div., divaricator muscle.
d. s., depressor sclerite of frontal membrane.
e., egg, or embryo.
f., fascia of occlusor muscle.
f. m., frontal membrane.
l. b., *l. b.*^{1}, ligamentous bands of tentacle-sheath.
m., mandible.
m. p., median process.
m. s., main sclerite, of operculum or mandible.
occ., occlusor muscle.
occ.^{1}, distal occlusor muscle of mandible.
occ.^{2}, proximal occlusor muscle of mandible.
occ. t., occlusor tubercle.
op., operculum.
ov., ovisac.
p. v., parieto-vaginal muscle.
p. vest., parieto-vestibular muscle.
r. p.$^{1-4}$, rosette-plates.
t., calcareous "polypide-tube".
tent., tentacles.
t. s., tentacle-sheath.
v., wall of vestibule.

Fig. 1. *Steganoporella magnilabris* (Busk) (p. 277). — Japan, 43, A (not Siboga Coll.). Longitudinal section of four stained, but not decalcified individuals, 1—4. 3 is an avicularium, and the others are zooecia. Obj. A.

Fig. 2. „ „ „ „ — Same slide. Longitudinal section, not decalcified, of an avicularium. Obj. A.

Fig. 3. „ „ „ „ — Same slide. Longitudinal section of distal part of an avicularium. Obj. C.

Fig. 4. *Steganoporella mandibulata* n. sp. (p. 279). — 394. A^{3}, Stat. 144. Operculum. Obj. C.

Fig. 5. *Steganoporella lateralis* MacGill. (p. 274). — 487. A, Stat. 129. Basal view of avicularium, showing origin of occlusor muscles (*occ.*) from the basal wall: *d. c.*, descending cryptocyst. Obj. A.

Fig. 6. „ „ „ „ — Same slide. Basal view of two zooecia, showing the reversed positions of the polypide-tubes and tentacles in adjacent individuals. Obj. A.

Fig. 7. *Steganoporella magnilabris* (Busk) (p. 277). — Same slide as fig. 1. Longitudinal section of distal part of a zooecium. Obj. C.

Fig. 8. *Steganoporella lateralis* MacGill. (p. 274). — 279. C^{2}, Stat. 250. Mandible and part of frontal membrane, with depressor sclerites, from the basal side. Obj. C.

Fig. 9. *Steganoporella magnilabris* (Busk) (p. 277). — 345. A^{1}, Stat. 213. An ordinary zooecium, in frontal view, showing an egg or embryo in an ovisac (*ov.*). Obj. C.

Fig. 10. *Steganoporella dilatata* n. sp. (p. 275). — 413. A^{1}, Stat. 315. Mandible, with part of frontal membrane and depressor sclerites, basal view. Obj. C.

Fig. 11. „ „ „ „ — Same slide. Similar view of an operculum. Obj. C.

Fig. 12. *Steganoporella magnilabris* (Busk) (p. 277). — Same slide as fig. 9. Basal view of distal part of zooecium, showing anatomy. Obj. C.

Fig. 13. *Steganoporella lateralis* MacGill. (p. 274). — Same slide as fig. 5. Distal ends of zooecium (left) and avicularium (right). Obj. C.

Fig. 14. *Poricellaria ratoniensis* (Waters) (p. 314). — 501. O, Stat. 163. Proximal part of a young colony Obj. A.

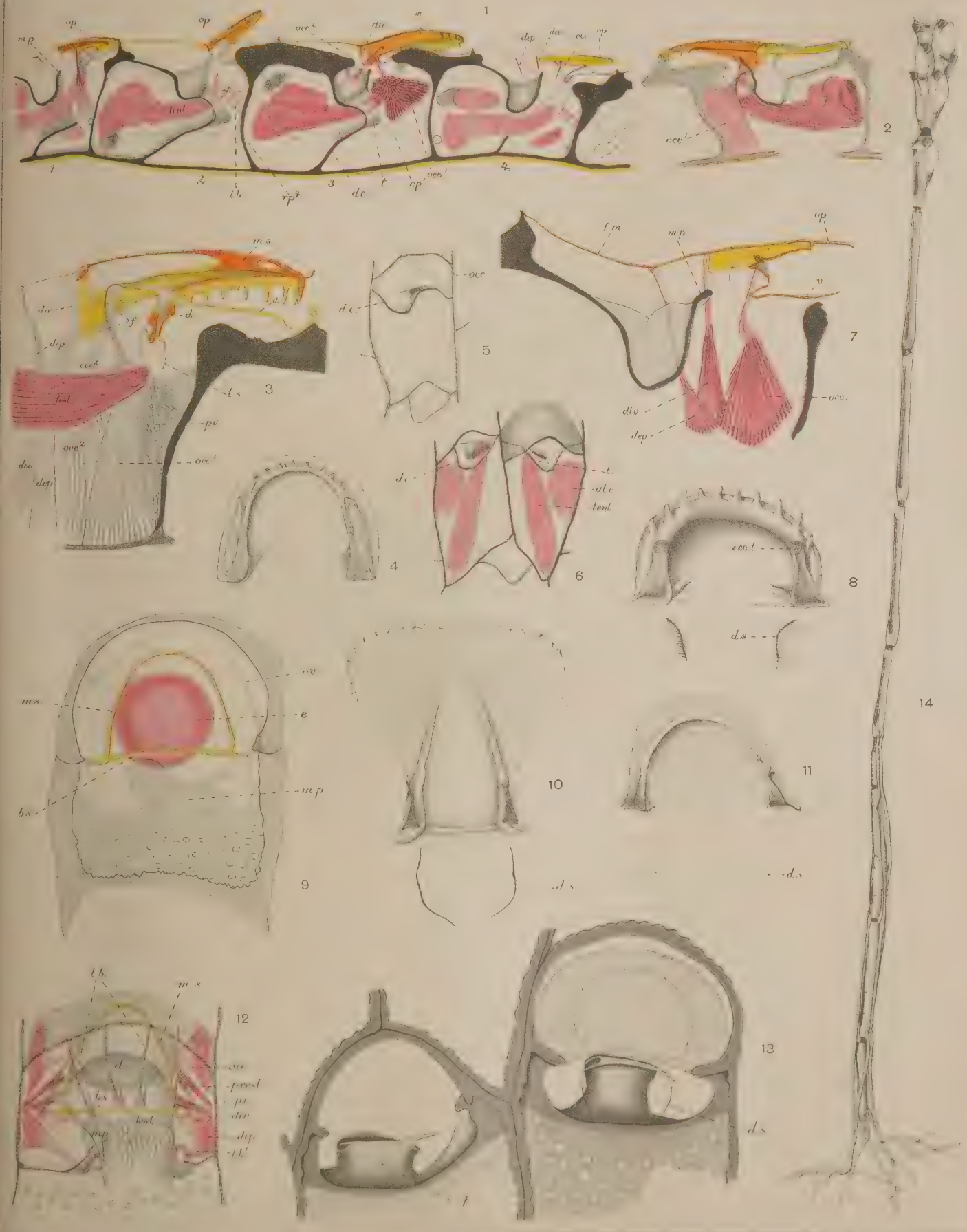

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PLATE XVIII.

FARCIMINARIIDAE (*Levinsenella*, *Farciminellum*).
BICELLARIELLIDAE (*Himantozoum*).

Fig. 1. *Levinsenella carinata* n. sp. (p. 403). — 155. A^3, Stat. 211. Part of a branch, cleaned with Eau de Javelle. Obj. A.

Fig. 2. „ „ „ „ — 529. A, Stat, 221. Parts of zooecia, with ovicell and pigmented lines. Obj. A.

Fig. 3. „ „ „ „ — 155. A^3, Stat. 211. Ovicell. Obj. A.

Fig. 4. *Himantozoum taurinum* n. sp. (p. 454). — 526. A^1, Stat. 211. Basal view, showing eggs in the zooecial cavities. Obj. A.

Fig. 5. *Levinsenella carinata* n. sp. (p. 403). — 155. A^1, Stat. 211. Parts of zooecia, with ovicell. Obj. A.

Fig. 6. *Himantozoum taurinum* n. sp. (p. 454). — 526. A^1, Stat. 211. Avicularia, marginal (left) and median (right). Obj. C.

Fig. 7. „ „ „ „ — Same slide. Zooecia and avicularia, frontal view. Obj. A.

Fig. 8. *Farciminellum hexagonum* (Busk) (p. 405). — 210. A^2, Stat. 295. Basal view. Obj. A.

Fig. 9. „ „ „ „ — Same slide. Mandible. Obj. C.

Fig. 10. „ „ „ „ — Same slide. Frontal view, showing two eggs. Obj. A.

Fig. 11. *Himantozoum emaciatum* n. sp. (p. 455). — 146. B^1, Stat. 170. Part of the basal tuft of rootlets; *r.*, enlarged rootlet; z^1, lowest zooecium. Obj. A.

Fig. 12. „ „ „ „ — Same slide. Part of zooecium, with avicularium. Obj. C.

Fig. 13. „ „ „ „ — Same slide. Bifurcation, basal view. For lettering see text, p. 456. Obj. A.

Fig. 14. „ „ „ „ — Same slide. Frontal view. For lettering see text. Obj. A.

Fig. 15. *Himantozoum taurinum* n. sp. (p. 454). — 156. A^1, Stat. 211. A marginal zooecium, from near the proximal end, showing strengthening calcareous bars; with two avicularia. Obj. A.

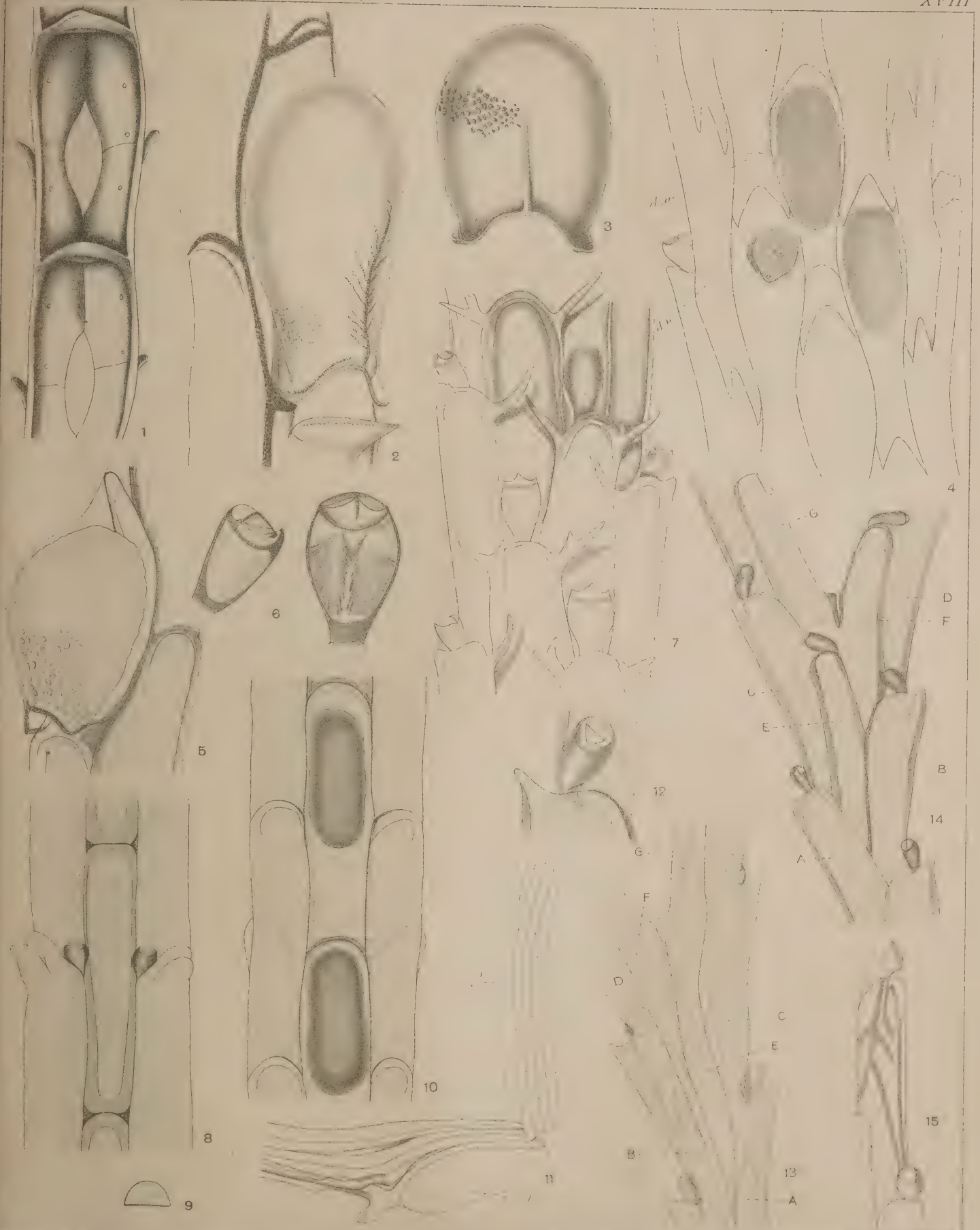

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PLATE XIX.

FARCIMINARIIDAE (*Didymozoum*).
THALAMOPORELLIDAE (*Thalamoporella*).

Fig. 1. *Didymozoum triseriale* (Phil.) (p. 407). — 57. O^1, Stat. 80. Zooecia and ovicell. Obj. A.
Fig. 2. *Didymozoum marginatum* n. sp. (p. 408). — 38. P^1, Stat. 77. Zooecia. Obj. A.
Fig. 3. *Thalamoporella rozieri* (Aud.) (p. 292). — 390. I^2, Stat. 99. Calipers. Obj. C.
Fig. 4. " " " " — 349. A^3, Stat. 240. Zooecia and ovicells. Obj. A.
Fig. 5. " " " " — 349. A^1, same Station. Avicularium with mandible. Obj. C.
Fig. 6. " " " " — Same slide. Gonozooecia and ovicells, immature and complete. Obj. A.
Fig. 7. " " " " — Same slide. Compasses, large and small, and calipers. Obj. C.
Fig. 8. " " " " — 364. F^1, Stat. 71. Mandibles. Obj. A.
Fig. 9. " " " " — 349. A^1, Stat. 240. Basal view, immature, to show method of calcification of basal insertion of cryptocyst: *A*, avicularium. Obj. A.
Fig. 10. " " " " — Same slide, mature. An ovicell is seen in the background. Obj. A.
Fig. 11. " " " " — 349. A^1, Stat. 240. Operculum. Obj. C.
Fig. 12. " " " " — Same slide. Primary operculum of young gonozooecium. Obj. C.
Fig. 13. " " " " — 364. F^4, Stat. 71. Mandible. Obj. C.
Fig. 14. *Thalamoporella novae-hollandiae* (Hasw.) (p. 295). — 291. A^4, Stat. 273. Operculum. Obj. C.
Fig. 15. " " " " — Same slide. Long and short compasses (calipers wanting). Obj. C.
Fig. 16. " " " " — 291. A^1, Stat. 273. Zooecia and avicularium. Obj. A.
Fig. 17. *Thalamoporella stapifera* Lev. (p. 297). — 290. B^2, Stat. 279. Basal view. Obj. A.
Fig. 18. *Thalamoporella novae-hollandiae* (Hasw.) (p. 295). — 291. A^4, Stat. 273. Mandible. Obj. C.
Fig. 19. " " " " — Same slide. Basal view. Obj. A.
Fig. 20. *Thalamoporella stapifera* Lev. (p. 297). — 290. B^2, Stat. 279. Operculum. Obj. C.
Fig. 21. " " " " — Same slide. Young gonozooecium. Obj. A.
Fig. 22. " " " " — 290. B^1, Stat. 279. Zooecia and ovicell, the latter showing its double operculum. Obj. A.
Fig. 23. " " " " — 290. B^2, Stat. 279. Small compasses and stirrup-shaped calipers. Obj. C.
Fig. 24. " " " " — Same slide. Gonozooecium with ovicell. Obj. A.
Fig. 25. " " " " — 290. B^1, Stat. 279. Zooecia. Obj. A.
Fig. 26. *Thalamoporella tubifera* Lev. (p. 298). — 206. A^1, Stat. 282. Compasses, long and short, and calipers. Obj. C.
Fig. 27. " " " " — 206. A^2, Stat. 282. Zooecia with secondary calcareous tubes, and avicularium. Obj. A.

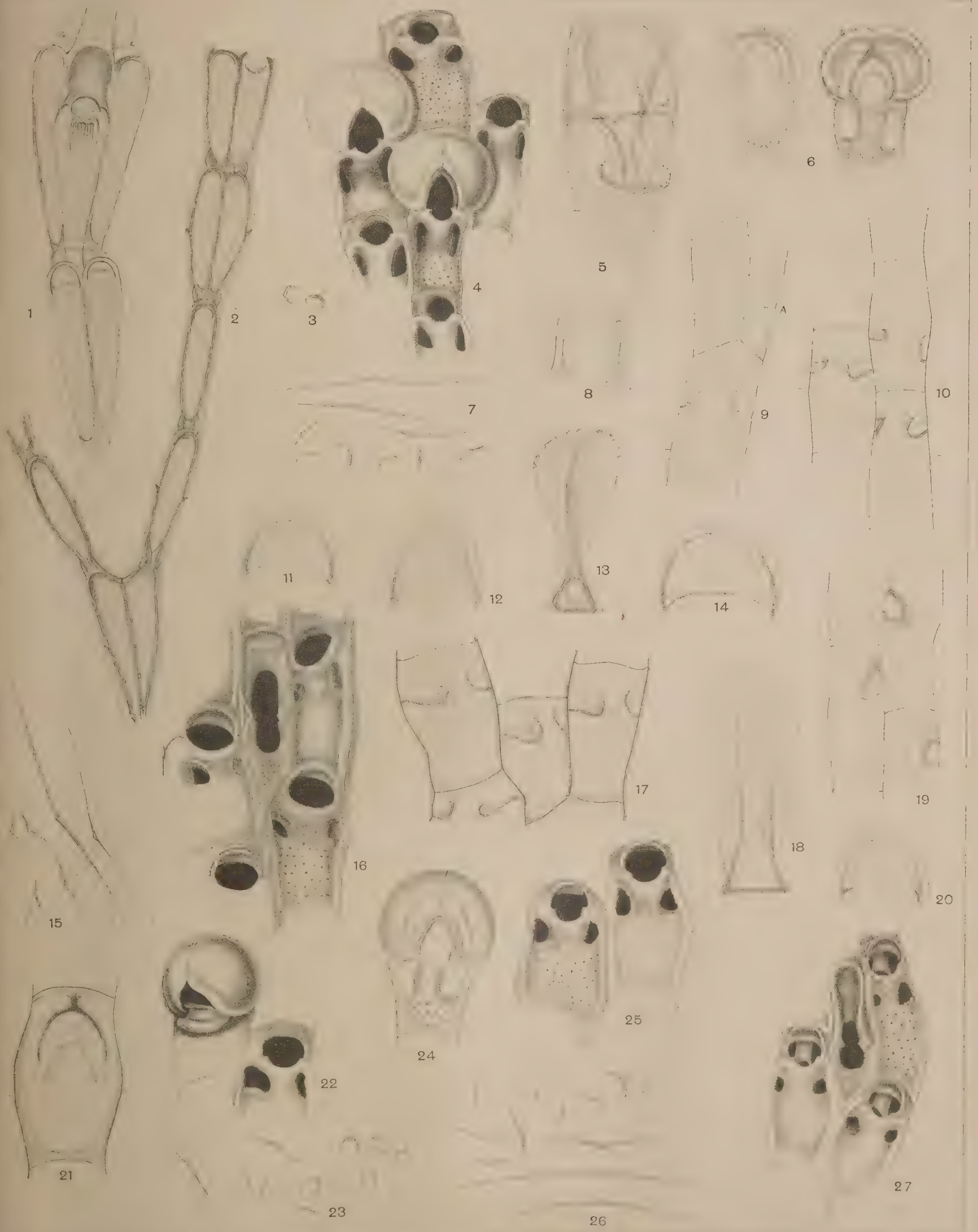

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PLATE XX.

THALAMOPORELLIDAE (*Thalamoporella*).
MICROPORIDAE (*Calpensia, Monoporella*).

Fig. 1. *Thalamoporella tubifera* Lev. (p. 298). — 206. A^1, Stat. 282. Zooecia and avicularium, basal view; showing the secondary calcareous tubes. Obj. A.

Fig. 2. *Thalamoporella expansa* Lev. (p. 300). — Torres Straits, 50 (not Siboga Coll.). Orifice of zooecium and avicularium. Obj. A.

Fig. 3. „ „ „ „ — Same material (another slide). Basal view of zooecia: *occ.*, origins of occlusor muscles. Obj. A.

Fig. 4. *Thalamoporella gothica* (Busk), var. *indica* Hincks (p. 303) — 371. E^2, Stat. 273. Zooecia and avicularia. Obj. A.

Fig. 5. „ „ „ „ „ „ „ — 291. B^2, Stat. 273. Zooecia and avicularium, with chitinous parts. Obj. A.

Fig. 6. „ „ „ „ „ „ „ — 371. E^1, Stat. 273. Compass (small) and calipers (large and small). Obj. C.

Fig. 7. „ „ „ „ „ „ „ — Same slide. Avicularium and zooecium, showing the adoral cavities (*ad.*). Obj. C.

Fig. 8. „ „ „ „ „ „ „ — Same slide. Avicularium, and zooecium, showing the position of the tentacles in relation to the opesiule, and spicules in the body-cavity; basal view. Obj. A.

Fig. 9. *Thalamoporella expansa* Lev. (p. 300). — Same slide as Fig. 3. Compasses, large and small (calipers wanting). Obj. C.

Fig. 10. „ „ „ „ — Same slide as Fig. 2. Zooecia. Obj. A.

Fig. 11. *Calpensia pulchra* n. sp. (p. 308). — Torres Straits, 169 (not Siboga Coll.) Zooecia. Obj. A.

Fig. 12. „ „ „ „ — Same slide. Basal view. Mainly from QJMS, XLVI, Pl. XVIII, fig. 57: *dep.*, origin of depressor; *occ.*, occlusor (not drawn with camera lucida).

Fig. 13. *Calpensia reversa* n. sp. (p. 309). — Ceylon, 23 (not Siboga Coll.), slide C. Zooecia and avicularium, with chitinous parts. Obj. A.

Fig. 14. „ „ „ „ — Same slide. Basal view, showing insertions of opesiules, and thin regions in the walls indicating the position of the communication-pores. Obj. C.

Fig. 15. „ „ „ „ — Same material, slide B. Opercula, the upper one from the distal side, to show the two teeth. Obj. C.

Fig. 16. „ „ „ „ — Same material, slide C. Mandible. Obj. C.

Fig. 17. *Thalamoporella hamata* n. sp. (p. 301). — 131. O^1, Stat. 164. Zooecia and avicularium. Obj. A.

Fig. 18. „ „ „ „ — 131. O^2, Stat. 164. Mandibles (the right one foreshortened) and operculum. Obj. C.

Fig. 19. „ „ „ „ — Same slide. Zooecia and two avicularia, basal view. Obj. A.

Fig. 20. „ „ „ „ — Same slide. Compasses (long) and calipers. Obj. C.

Fig. 21. *Monoporella nodulifera* (Hincks) (p. 310). — 108. U^1, Stat. 144. Zooecia and ovicell. Obj. A.

Fig. 22. „ „ „ „ — Same slide. Zooecia, cleaned. Obj. A.

Fig. 23. „ „ „ „ — Same slide. Operculum. Obj. C.

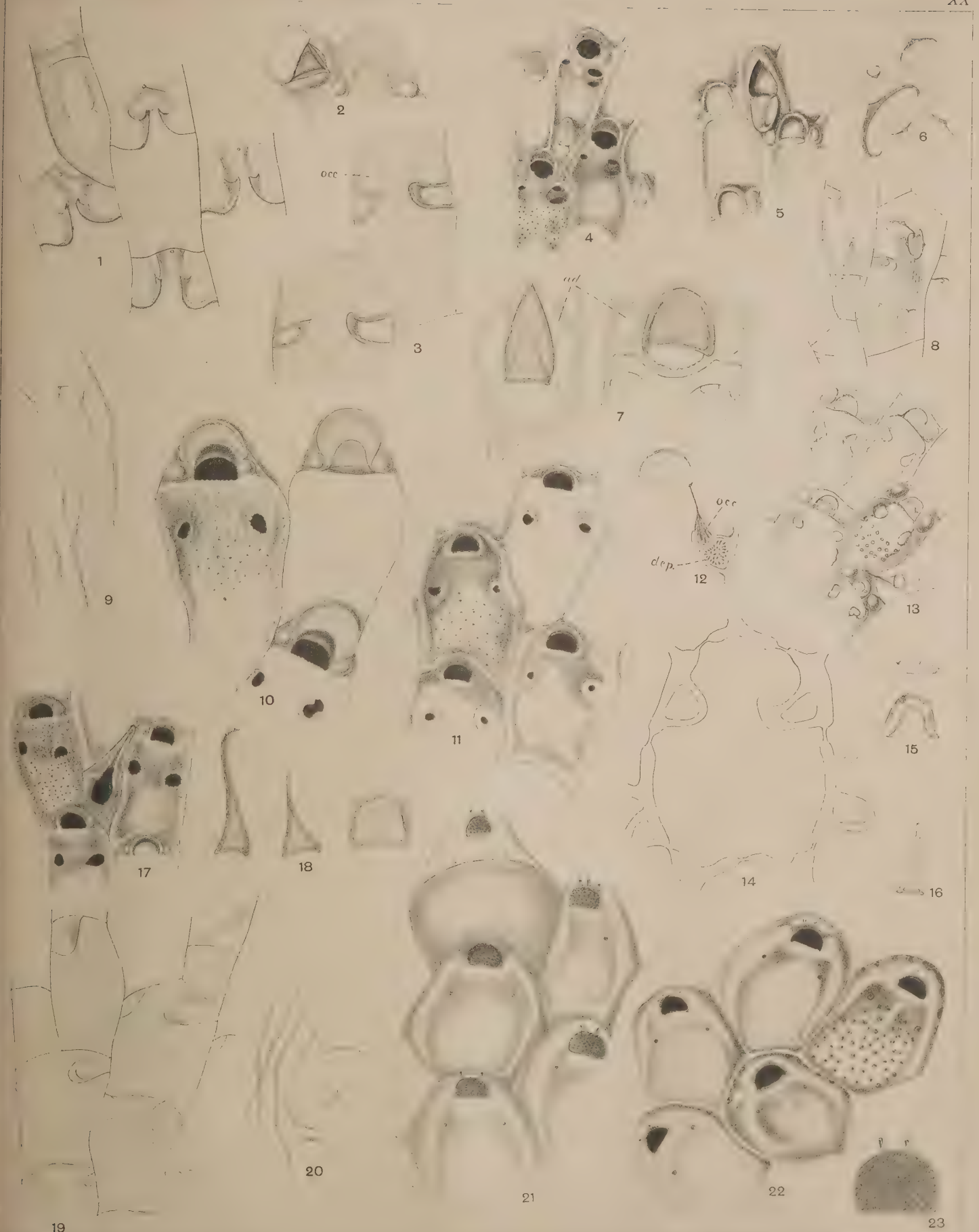

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PLATE XXI.

LABIOPORELLIDAE (*Labioporella*).
CELLARIIDAE (*Cellaria*, *Syringotrema*).

Fig. 1. *Labioporella crenulata* Lev. (p. 282). — Torres Straits, 104[1] (not Siboga Coll.). Zooecia and avicularia; cleaned and with chitinous parts. Obj. A.

Fig. 2. „ „ „ „ — 104[2], same material. Mandible (overstained, the details not ascertainable). Obj. C.

Fig. 3. „ „ „ „ — Same slide as Fig. 1. Distal ends of zooecia in basal view, showing two modes of the insertion of the descending cryptocyst. Drawn without camera lucida.

Fig. 4. *Labioporella spatulata* n. sp. (p. 283). — 251. L[1], Stat. 315. Three similar views. Drawn without camera lucida.

Fig. 5. „ „ „ „ — Same slide. Mandible. Obj. C.

Fig. 6. „ „ „ „ — 251. L[3], Stat. 315. Avicularium and zooecia, two with chitinous parts. Obj. A.

Fig. 7. *Labioporella cornuta* n. sp. (p. 286). — 108. AC[1], Stat. 144. Zooecium. Obj. A.

Fig. 8. *Labioporella thornelyae* n. sp. (p. 287). — Ceylon (not Siboga Coll.). Zooecium and avicularium. Obj. A.

Fig. 9. „ „ „ „ — Same material. Mandible. Obj. C.

Fig. 10. *Cellaria tecta* n. sp. (p. 340). — 95. A[3], Stat. 122. Operculum and depressor sclerites. Obj. C.

Fig. 11. „ „ „ „ — Same slide. Another operculum with depressor sclerites, seen obliquely. The muscles are an occlusor and another probably representing the depressor + divaricator. Obj. C.

Fig. 12. *Labioporella bursaria* (MacGill.) (p. 285). — 364. E[2], Stat. 71. Mandible. Obj. C.

Fig. 13. „ „ „ „ — 364. E[1]. Stat. 71. Zooecium and avicularium. Obj. A.

Fig. 14. *Cellaria punctata* (Busk) (p. 337). — 396. B, Stat. 162. The greater part of the fertile swelling of an internode, showing young zooecia, ovicells and an avicularium. Obj. A.

Fig. 15. „ „ „ „ — 16. G[2], Stat. 49[a]. Two opercula, with depressor sclerites (*d. s.*). In the lower figure the sclerites are connected by a network of chitinous thickenings. Obj. C.

Fig. 16. „ „ „ „ — Same slide. Mandible. Obj. C.

Fig. 17. *Cellaria tecta* n. sp. (p. 340). — 95. A[2], Stat. 122. Zooecium showing (below) the origin of a rootlet. Obj. A.

Fig. 18. „ „ „ „ — 95. A[3], Stat. 122. Mandible. Obj. C.

Fig. 19. „ „ „ „ — Same slide. Mandible, side view. Obj. C.

Fig. 20. „ „ „ „ — Same slide as Fig. 17. Zooecia, ovicells (*ov.*) and avicularium: *m.p.*, median process, projecting into the orifice of an ovicell. Obj. A.

Fig. 21. *Cellaria anceps* n. sp. (p. 343). — 499. D[1], Stat. 161. Part of the colony, showing an ovicell. Obj. A.

Fig. 22. *Syringotrema auriculatum* n. gen., n. sp. (p. 346). — 6. A[3], Stat. 12. Operculum with its sclerite, on the proximal side of which is another sclerite belonging to the margin of the opesia. Obj. C.

Fig. 23. „ „ „ „ „ — 6. A[1]. Stat. 12. Zooecia and avicularium. Obj. A.

Fig. 24. „ „ „ „ „ — 156. C[1], Stat. 211. Young zooecia, drawn without camera lucida.

Fig. 25. „ „ „ „ „ — 6. A[3], Stat. 12. Mandible. Obj. C.

Fig. 26. „ „ „ „ „ — 6. A[1], Stat. 12. Ovicells and parts of zooecia. Obj. A.

Fig. 27. *Cellaria praelonga* n. sp. (p. 342). — 153. B[1], Stat. 211. Avicularium. Obj. C.

Fig. 28. „ „ „ „ — Same slide. Part of bifurcation, showing the "nodate" joint. Obj. A.

Fig. 29. „ „ „ „ — Same slide. Zooecium showing the origin of a rootlet. Obj. A.

Fig. 30. „ „ „ „ — 155. B[3], Stat. 211. Part of an internode, with an avicularium; showing, proximally, apertures from which originate the chitinous tubes of a joint. Obj. A.

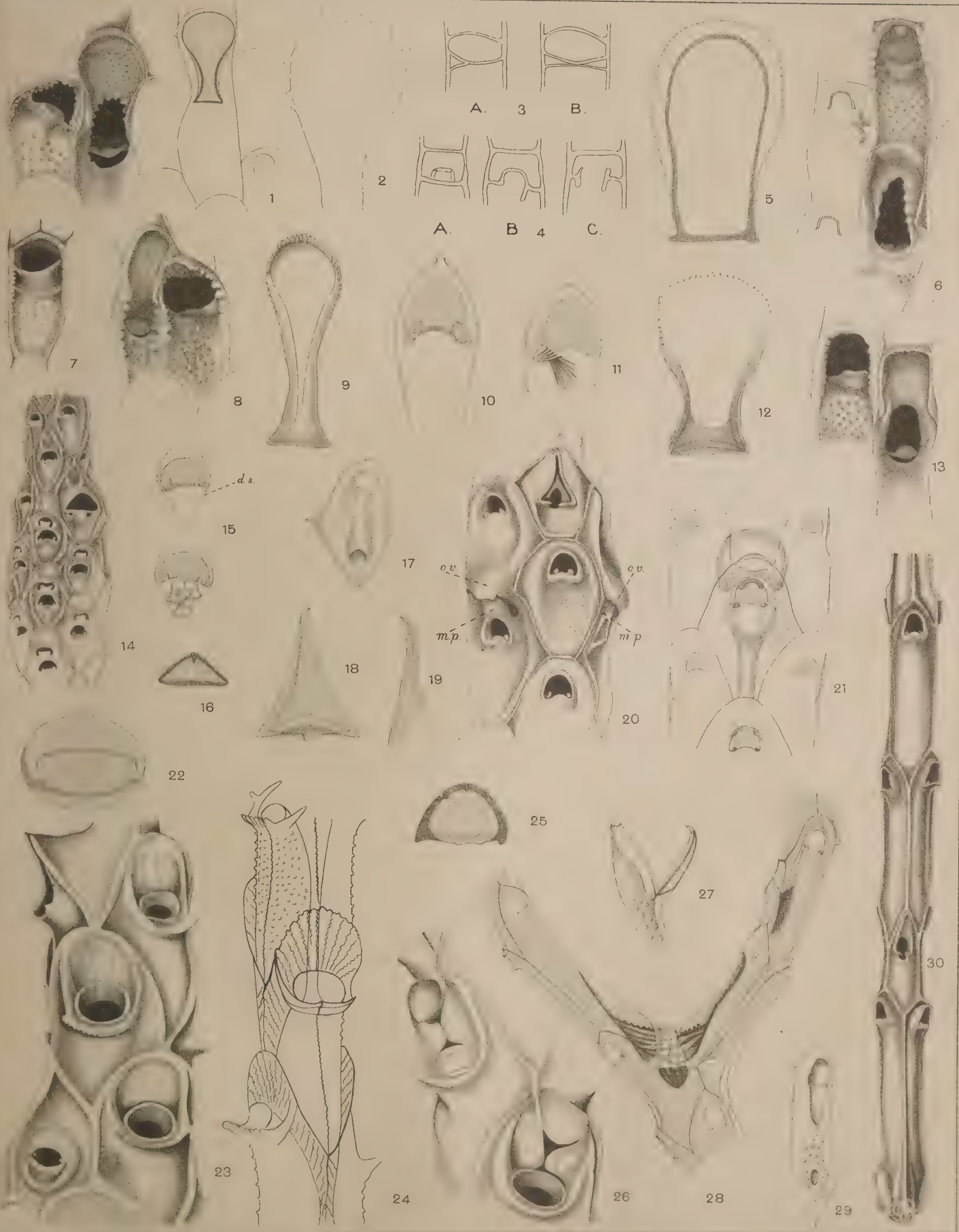

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PLATE XXII.

ASPIDOSTOMATIDAE (*Aspidostoma, Lagarozoum, Crateropora*).

Fig. 1. *Aspidostoma cylindricum* n. sp. (p. 323). — 478. D, Stat. 107. Part of the cylindrical branch, the second median zooecium from the bottom with an ovicell. The lowest zooecium was drawn from 535. A^3, Stat. 226. Obj. a^3 (Greenough).

Fig. 2. „ „ „ „ — 535. A^2, Stat. 226. Operculum, with occlusor (*occ.*) and depressor (*dep.*) muscles. Obj. C.

Fig. 3. „ „ „ „ — Same slide. Mandible, with occlusor muscle (*occ.*). The proximal muscle is probably a proximal occlusor: *d.s.*, distal sclerite. Obj. C.

Fig. 4. „ „ „ „ — 478. D, Stat. 107. Transverse section of branch, drawn before mounting. Obj. A.

Fig. 5. *Lagarozoum profundum* n. gen., n. sp. (p. 325). — 403. A^1, Stat. 251. Distal end of a fertile zooecium. Obj. a^3 (Greenough).

Fig. 6. „ „ „ „ „ — 111. K^1, Stat. 156. Avicularium and zooecia, two with depressor sclerites. The mandible was accidentally reversed in mounting. Obj. a^3. (Greenough).

Fig. 7. „ „ „ „ „ — 403. A^2, Stat. 251. Part of frontal membrane, with depressor sclerites (*d.s.*), a depressor muscle (*dep.*), the operculum and an occlusor muscle (*occ.*). The arrow indicates the cavity between the two layers of the operculum. Obj. C.

Fig. 8. *Crateropora expansa* n. sp. (p. 331). — 543. B^4, Stat. 260. Operculum. Obj. C.

Fig. 9. „ „ „ „ — 543. B^3, Stat. 260. Zooecia, one with an ovicell, and avicularia. Obj. a^3 (Greenough).

Fig. 10. „ „ „ „ — Same slide. Side view, to show the septula. For explanation of the lettering see text, p. 329. Obj. A.

Fig. 11. „ „ „ „ — 543. B^2, Stat. 260. Basal view of distal end of zooecium: *occ.*, occlusor; *dep.*, depressor; *l.r.*, lateral recess. Obj. A.

Fig. 12. „ „ „ „ — Same slide. Young zooecium: *c.r.*, cryptocyst-ridge; *l.r.*, lateral recess; *t*, edge of calcareous tube. Drawn without camera lucida.

Fig. 13. „ „ „ „ — 543. B^4, Stat. 260. Mandible. Obj. C.

Fig. 14. *Crateropora falcata* Lev. (p. 331). — 393. A^2, Stat. 133. Basal view of distal end of zooecium, showing the insertion of the lateral recesses into the distal wall. This runs obliquely and frontally from its loop-like insertion (*d.w.*) into the basal wall (*b.*). The uppermost curved line in the figure is the frontal edge of the distal wall, and the next line of similar form is the edge of the oral arch. Drawn without camera lucida.

Fig. 15. „ „ „ „ — Same slide. Zooecia and avicularium. Obj. a^3 (Greenough).

Fig. 16. *Crateropora foraminata* n. sp. (p. 333). — 550. A^1, Stat. 305. Zooecia with two ovicells, indicated by their independent orifices. Obj. a^3 (Greenough).

Fig. 17. „ „ „ „ — Same slide. Zooecium and avicularia: *dep.* depressor muscle. Obj. A.

Fig. 18. „ „ „ „ — Same slide. Basal view of a zooecium from which the basal wall has been removed: *l.r.*, lateral recess; *op.* opesia. Obj. A.

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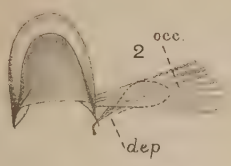

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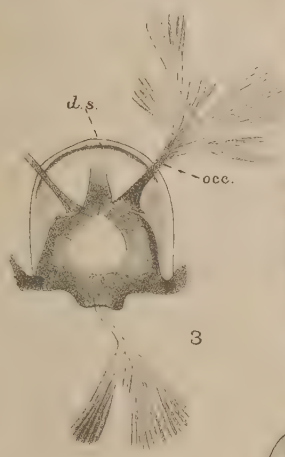

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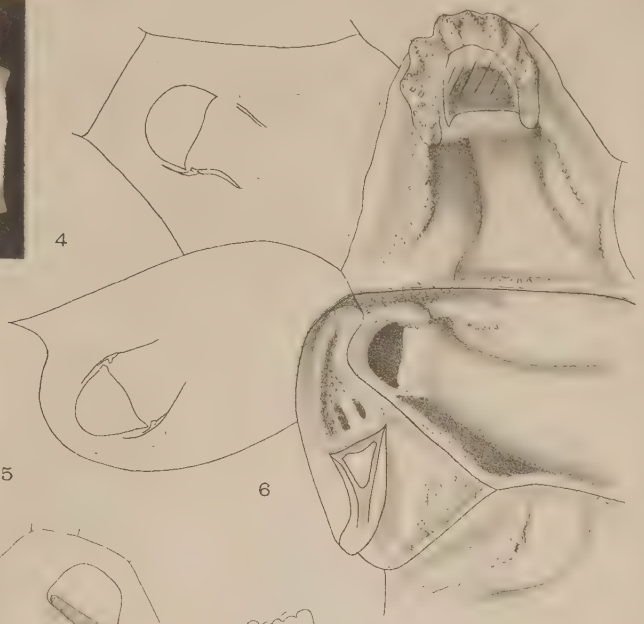

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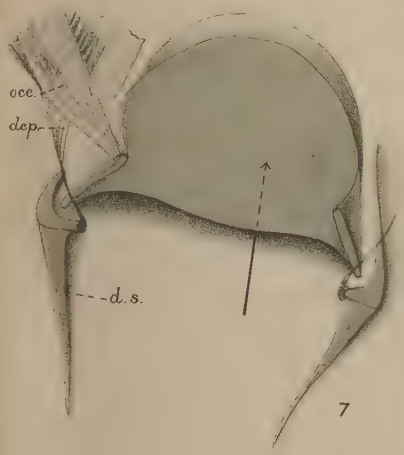

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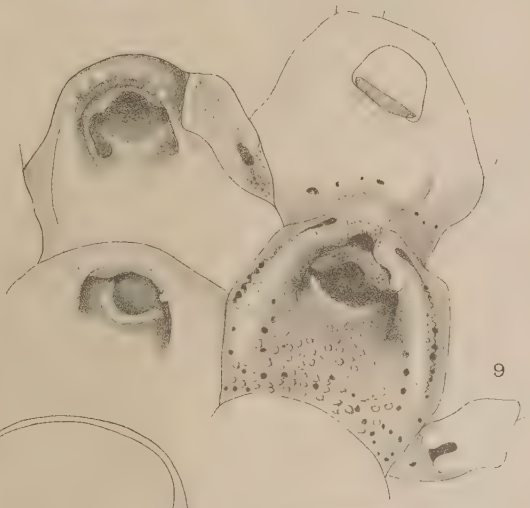

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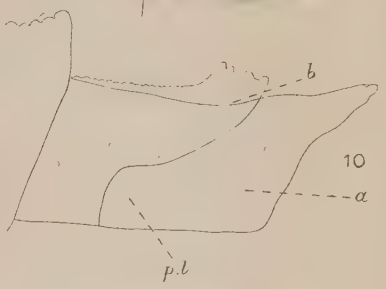

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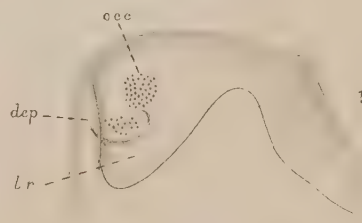

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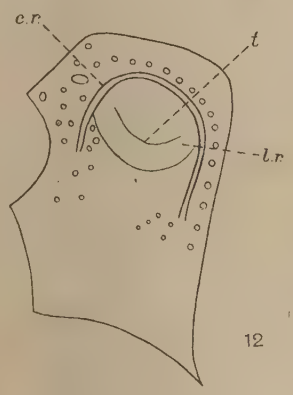

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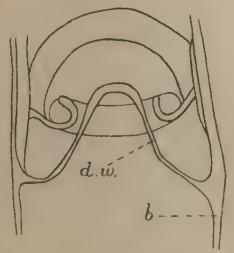

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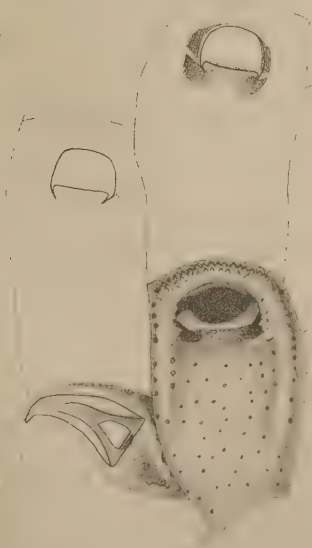

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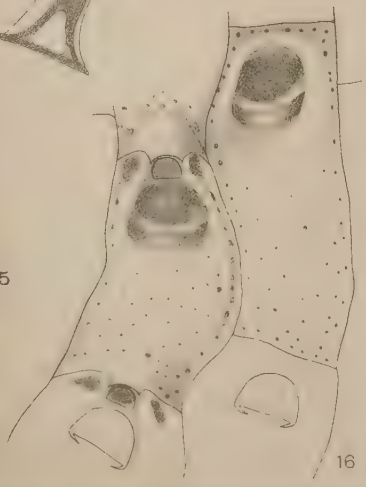

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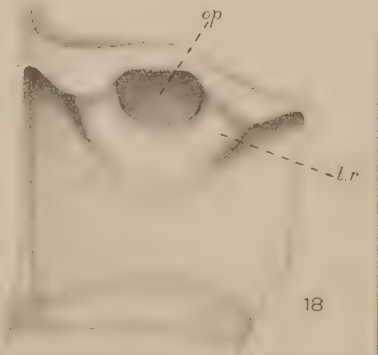

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PLATE XXIII.

SCRUPARIIDAE (*Brettia*).
PORICELLARIIDAE (*Poricellaria*).
SCRUPOCELLARIIDAE (*Amastigia, Notoplites*).

Fig. 1. *Brettia mollis* n. sp. (p. 198). — 619. B^1, Stat. 2. Zooecia. A rootlet is shown at the bottom of the figure. Obj. A.

Fig. 2. „ „ „ „ — Same slide. Zooecia. Obj. A.

Fig. 3. *Poricellaria ratoniensis* (Waters) (p. 314). — 332. A^3, Stat. 64. Opercula. Obj. C.

Fig. 4. „ „ „ „ — Same slide. Mandibles. Obj. C.

Fig. 5. „ „ „ „ — Same slide. Chitinous tubes of a joint. Not drawn with camera lucida.

Fig. 6. „ „ „ „ — 332. A^2, Stat. 64. Frontal view. Obj. A.

Fig. 7. „ „ „ „ — Same slide. Basal view. Obj. A.

Fig. 8. „ „ „ „ — Same slide. Side view. Obj. A.

Fig. 9. *Amastigia rudis* (Busk) (p. 349). — 459. D, Stat. 81. Showing ovicell, scuta and frontal avicularia. Obj. A.

Fig. 10. „ „ „ „ — Same slide. Zooecia, ovicells and avicularia. Obj. A.

Fig. 11. „ „ „ „ — 101. F, Stat. 133. Two zooecia, with scuta and avicularium. Obj. A.

Fig. 12. „ „ „ „ — 459. D, Stat. 81. Basal view, showing vibracula, frontal avicularia (*f. av.*) and marginal avicularia (*m. av.*); the seta represented in the upper vibraculum only. Obj. A.

Fig. 13. „ „ „ „ — 183. A^2, Stat. 260. Seta and three mandibles. Obj. C.

Fig. 14. *Notoplites rostratus* Harm. (p. 352). — 526. C^1, Stat. 211. Mandible of large frontal avicularium of a fertile zooecium. Obj. C.

Fig. 15. „ „ „ „ — Same slide. Zooecia, scuta, avicularia and ovicells. Obj. A.

Fig. 16. „ „ „ „ — Same slide. Basal view of bifurcation, showing the two large avicularia of the zooecia F and G: *Jt*, joint. For notation of the zooecia see text, p. 351. Obj. A.

Fig. 17. „ „ „ „ — Same slide. Basal view. Obj. A.

Fig. 18. *Notoplites scutatus* n. sp. (p. 353). — 499. A^1, Stat. 161. Zooecia with scuta, marginal avicularia and ovicell. Obj. A.

Fig. 19. „ „ „ „ — Same slide. Part of zooecium, with scutum, marginal avicularium and ovicell. Obj. C.

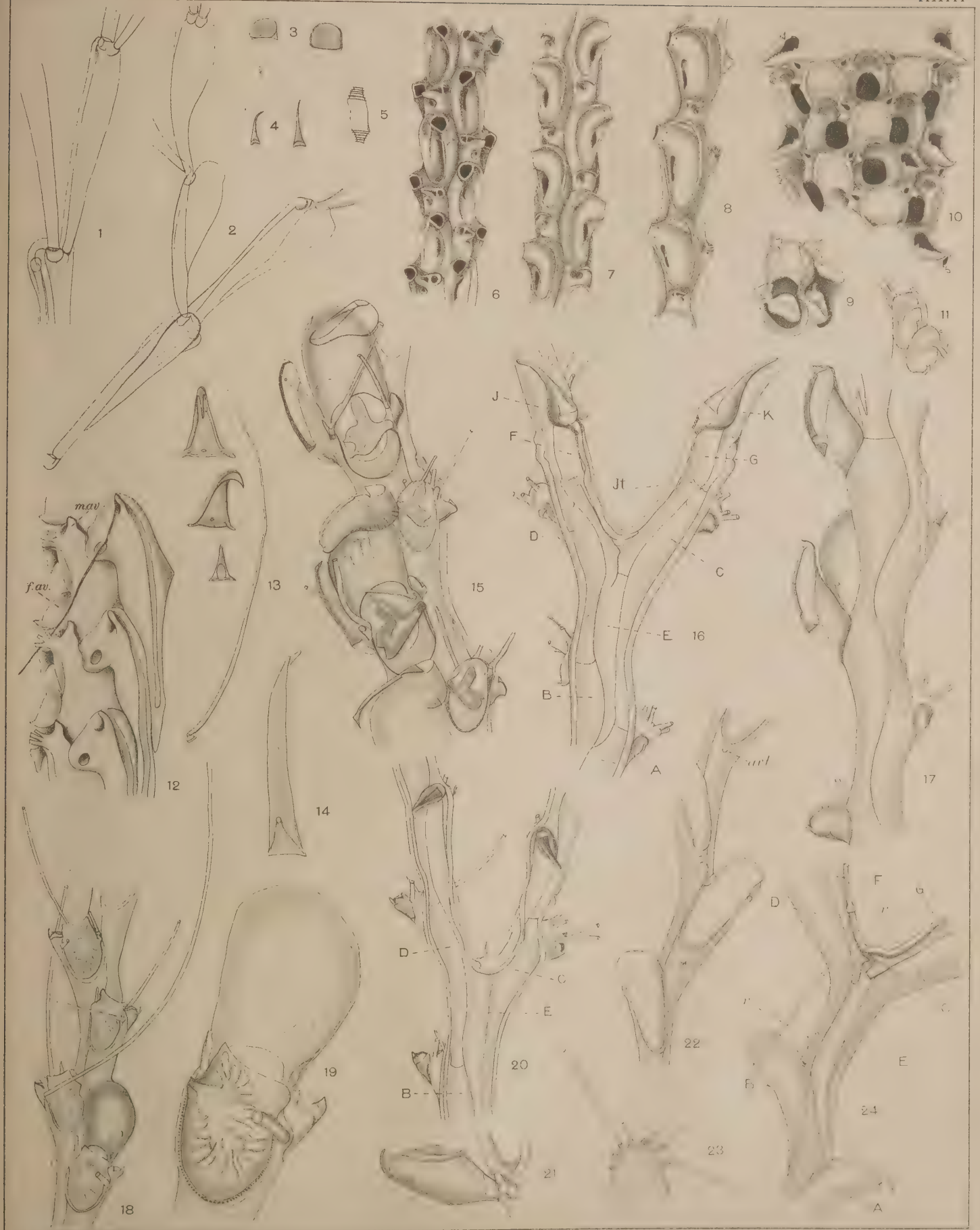
Fig. 20. „ „ „ „ — Same slide. Basal view of bifurcation. For lettering see text, p. 351. Obj. A.

Fig. 21. *Notoplites obliquidens* n. sp. (p. 355). — 156. B, Stat. 211. Frontal avicularium, its stalk broken. Obj. C.

Fig. 22. „ „ „ „ — Same slide. Frontal view: *av. t.*, tubercle bearing the avicularium, which has been lost. Obj. A.

Fig. 23. „ „ „ „ — Same slide. Part of a zooecium from near the proximal end of the colony. Obj. A.

Fig. 24. „ „ „ „ — Same slide. Basal view of a bifurcation. The joints should occur on the distal sides of C and D, but the branch is young and they are not yet formed: *r.*, rootlets. For notation of zooecia see text, p. 351. Obj. A.



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Fa. P. W. M. Trap impr.

PLATE XXIV.

SCRUPOCELLARIIDAE (*Notoplites, Tricellaria, Caberea*).

Fig. 1. *Tricellaria aquilina* n. sp. (p. 356). — 536. A^1, Stat. 227. Avicularium and part of ovicell, basal view. Obj. C.

Fig. 2. „ „ „ „ — Same slide. Bifurcation. For notation of zooecia see text, pp. 356, 357. Obj. A.

Fig. 3. *Tricellaria scalariformis* n. sp. (p. 358). — 112. I, Stat. 156. Bifurcation, basal view. For explanation see text, pp. 356, 358. Obj. A.

Fig. 4. „ „ „ „ — Same slide. Bifurcation, frontal view; one only of the branches with a scalariform joint. Obj. A.

Fig. 5. *Caberea transversa* n. sp. (p. 363). — 242. A^2, Stat. 310. Part of internode, with ovicells, scuta and minute frontal avicularia. Obj. A.

Fig. 6. *Tricellaria aquilina* n. sp. (p. 356). — 536. A^1, Stat. 227. Bifurcation, one only of the branches jointed; frontal view. D^1 and F^1 are lettered alternatively as A^2 and B^2, their designation as members of the branch. See text-fig. 16, p. 357. Obj. A.

Fig. 7. *Caberea lata* Busk (p. 360). — 194. B, Stat. 274. Zooecia of a young colony, frontal view. Obj. A.

Fig. 8. „ „ „ „ — Same slide. Zooecia, avicularia and three ovicells. Obj. A.

Fig. 9. „ „ „ „ — 242. B^2, Stat. 310. Seta of vibraculum. Obj. C.

Fig. 10. *Caberea transversa* n. sp. (p. 363). — 242. A^3, Stat. 310. Seta of vibraculum. Obj. C.

Fig. 11. *Notoplites impar* n. sp. (p. 354). — 114. B, Stat. 159. Basal view of bifurcation, one only of the branches jointed; showing the characteristic avicularium. Notation of zooecia as in other cases. Obj. A.

Fig. 12. „ „ „ „ — Same slide. Bifurcation, frontal view. Obj. A.

Fig. 13. *Caberea boryi* (Aud.) (p. 362). — 423. A, Stat. 181. Showing scuta, ovicells and frontal avicularia, one of which is gigantic. Obj. A.

Fig. 14. „ „ „ „ — Same slide. Two gigantic frontal avicularia. Obj. C.

Fig. 15. „ „ „ „ — Same slide. Basal view, showing the vibracula. Obj. A.

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PLATE XXV.

SCRUPOCELLARIIDAE (*Scrupocellaria*).

Fig. 1. *Scrupocellaria ferox* Busk (p. 367). — 2. A^3, Stat. 7. Seta of a vibraculum and base of a second seta. Obj. C.

Fig. 2. " " " " — 2. A^1, Stat. 7. Zooecia, ovicells and avicularia. Obj. A.

Fig. 3. " " " " — Same slide. Basal view, with vibraculum. Obj. A.

Fig. 4. " " " " — 2. A^3, Stat. 7. Basal view of young joints at a bifurcation: *m. av.*, marginal avicularium; *v.*, vibraculum. Obj. A.

Fig. 5. " " " " — Same slide. Mandibles; left and middle, frontal; right, marginal. Obj. C.

Fig. 6. " " " " — Same slide. Frontal mandible. Obj. C.

Fig. 7. *Scrupocellaria serrata* Waters (p. 369). — 507. A, Stat. 164. Zooecia with scuta, avicularia and ovicells. Obj. A.

Fig. 8. " " " " — Same slide. Basal view, showing two avicularia; and terminal portion of a mandible. Obj. A.

Fig. 9. *Scrupocellaria securifera* Busk (p. 373). — 251. B, Stat. 315. Zooecia with scuta, avicularia and ovicells. Obj. A.

Fig. 10. " " " " — 37. N, Stat. 77. Basal view of two vibracula. Obj. A.

Fig. 11. " " " " — 543. A^3, Stat. 260. Mandibles; left, two frontal; right, two marginal. Obj. C.

Fig. 12. *Scrupocellaria delilii* (Aud.) (p. 370). — 299. F^1, Stat. 273. Opesia and scutum. Obj. C.

Fig. 13. " " " " — 344. B^1, Stat. 213. Zooecia, scuta, avicularia and ovicells. Obj. A.

Fig. 14. " " " " — 299. F^1, Stat. 273. Showing two kinds of marginal avicularia. Obj. A.

Fig. 15. " " " " — Same slide. Basal view, with vibracula and avicularia. Obj. A.

Fig. 16. *Scrupocellaria maderensis* Busk (p. 372). — 208. G, Stat. 282. Zooecia, scuta, avicularia and ovicells. Obj. A.

Fig. 17. " " " " — Same slide. Basal view, with vibracula and avicularia. Obj. A.

Fig. 18. " " " " — 31. I^1, Stat. 53. Zooecium with scutum and avicularium. Obj. A.

Fig. 19. " " " " — 31. I^2, Stat. 53. Seta, operculum and two marginal mandibles. Obj. C.

Fig. 20. *Scrupocellaria diadema* Busk (p. 375). — 501. G^1, Stat. 163. Zooecia with large scuta, marginal and frontal avicularia (one frontal avicularium enlarged), vibracula and ovicell. Obj. A.

Fig. 21. " " " " — 37. P^2, Stat. 77. Zooecia with small scuta, avicularia, vibracula and ovicells. Two frontal avicularia are enlarged. Obj. A.

Fig. 22. " " " " — 427. A. Stat. 60. Zooecia with rather larger scuta, and ovicells; etc. Three frontal avicularia are enlarged. Obj. A.

Fig. 23. " " " " — 555. A, Stat. 320. Bifurcation. The joints traverse the opesiae of the outer zooecia. Scuta are wanting. Frontal avicularia are not present in all cases, and one is enlarged. Obj. A.

Fig. 24. " " " " — 37. P^3, Stat. 77. Mandibles; of an enlarged frontal avicularium, and of a smaller marginal avicularium. Obj. C.

Fig. 25. " " " " — 37. P^2, Stat. 77. Basal view, with vibracula and marginal avicularia. Obj. A.

Fig. 26. *Scrupocellaria longispinosa* n. sp. (p. 381). — 108. AI^2, Stat. 144. Zooecia, with scuta and avicularia, one enlarged, and vibracula. Obj. A.

Fig. 27. " " " " — 374. L, Locality not recorded. Zooecia, scuta and avicularia. Obj. A.

Fig. 28. " " " " — 191. A^1, Stat. 274. The scuta are more complicated, their cavity with recurrent branches. Obj. A.

Fig. 29. " " " " — 108. AI^2, Stat. 144. Four mandibles, the two largest axillary. Obj. C.

Fig. 30. " " " " — 191. A^1, Stat. 274. Zooecia with long spines, some branched. Obj. A.

Fig. 31. " " " " — 108. AI^2, Stat. 144. Vibraculum and marginal avicularium, basal view. Obj. A.

Fig. 32. " " " " — 191. A^1, Stat. 274. From the branch shown in fig. 28. Scutum, its cavity with recurrent branches, Obj. C.

Fig. 33. " " " " — 108. AI^2, Stat. 144. Scutum, its recurrent branches very wide. Obj. C.

Fig. 34. " " " " — 374. L, Locality not recorded. Three scuta from one branch, their cavities showing varying degrees of complexity. Obj. C.

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PLATE XXVI.

SCRUPOCELLARIIDAE (*Scrupocellaria, Canda*).

Fig. 1. *Scrupocellaria spatulata* (D'Orb.) (p. 382). — 37. J^2, Stat. 77. Part of zooecium with vibraculum and large marginal avicularium. Obj. C.

Fig. 2. „ „ „ „ — Same slide. Scutum. Obj. C.

Fig. 3. „ „ „ „ — 299. I^1, Stat. 273. Scutum, its cavity with six recurrent branches. Obj. C.

Fig. 4. „ „ „ „ — 37. J^2, Stat. 77. Zooecia, scuta, ovicells and small marginal avicularia, at a bifurcation. The joints pass on the proximal sides of the opesiae of the outer zooecia. Obj. A.

Fig. 5. „ „ „ „ — 482. D, Stat. 116. Mandible of large marginal avicularium. Obj. C.

Fig. 6. „ „ „ „ — 37. J^2, Stat. 77. Bifurcation, basal view: *ax. v.*, the single axillary vibraculum; C^1, C^2 and D^1, D^2, the proximal and distal sections of the zooecia C and D; E, axillary zooecium; *v.*, vibraculum. Notation of zooecia as in other cases (text, p. 365). Obj. A.

Fig. 7. „ „ „ „ — 57. T, Stat. 80. Scutum with simple cavity. Obj. C.

Fig. 8. „ „ „ „ — Same slide. Zooecia, scuta, frontal avicularia, vibracula and ovicells. Obj. A.

Fig. 9. „ „ „ „ — 37. J^3, Stat. 77. Mandibles of marginal avicularia, one minute, two greatly enlarged. Obj. C.

Fig. 10. „ „ „ „ — 299. I^1, Stat. 273. Zooecia, scuta, frontal and marginal avicularia (two enlarged) and ovicells. Obj. A.

Fig. 11. *Scrupocellaria curvata* n. sp. (p. 380). — 299. D, Stat. 273. Zooecia with large scuta and vibracula and small frontal avicularia. Obj. A.

Fig. 12. „ „ „ „ — 245. B, Stat. 310. Vibracula, basal view. Obj. A.

Fig. 13. „ „ „ „ — 259. D, Stat. 318. Mandibles of two frontal avicularia. Obj. C.

Fig. 14. „ „ „ „ — Same slide. Decalcified. Chitinous parts of joints, en échelon: *ax. v.*, axillary vibraculum. Obj. A.

Fig. 15. „ „ „ „ — Same slide. Decalcified. Bifurcation, young, basal view; with axillary vibraculum. Obj. A.

Fig. 16. *Scrupocellaria obtecta* Hasw. (p. 378). — 37. ZC, Stat. 77. Basal view, with vibracula. Obj. A.

Fig. 17. „ „ „ „ — Same slide. Zooecia with large scuta and vibracula, frontal and marginal avicularia and ovicells. Obj. A.

Fig. 18. „ „ „ „ — 459. L, Stat. 81. Mandibles of two frontal avicularia. Obj. C.

Fig. 19. *Canda clypeata* (Hasw.) (p. 387). — 177. A^1, Stat. 257. Zooecia, scuta, large frontal avicularia and vibracula. Obj. A.

Fig. 20. „ „ „ „ — 177. A^3, Stat. 257. Setae of two vibracula, mandibles of two frontal avicularia. Obj. C.

Fig. 21. *Canda foliifera* n. sp. (p. 386). — 224. A, Stat. 305. Zooecia, scuta, vibracula and ovicells. Obj. A.

Fig. 22. „ „ „ „ — Same slide. Similar branch, cleaned with Eau de Javelle. Obj. A.

Fig. 23. „ „ „ „ — Same slide. Vibracula, basal view. Obj. A.

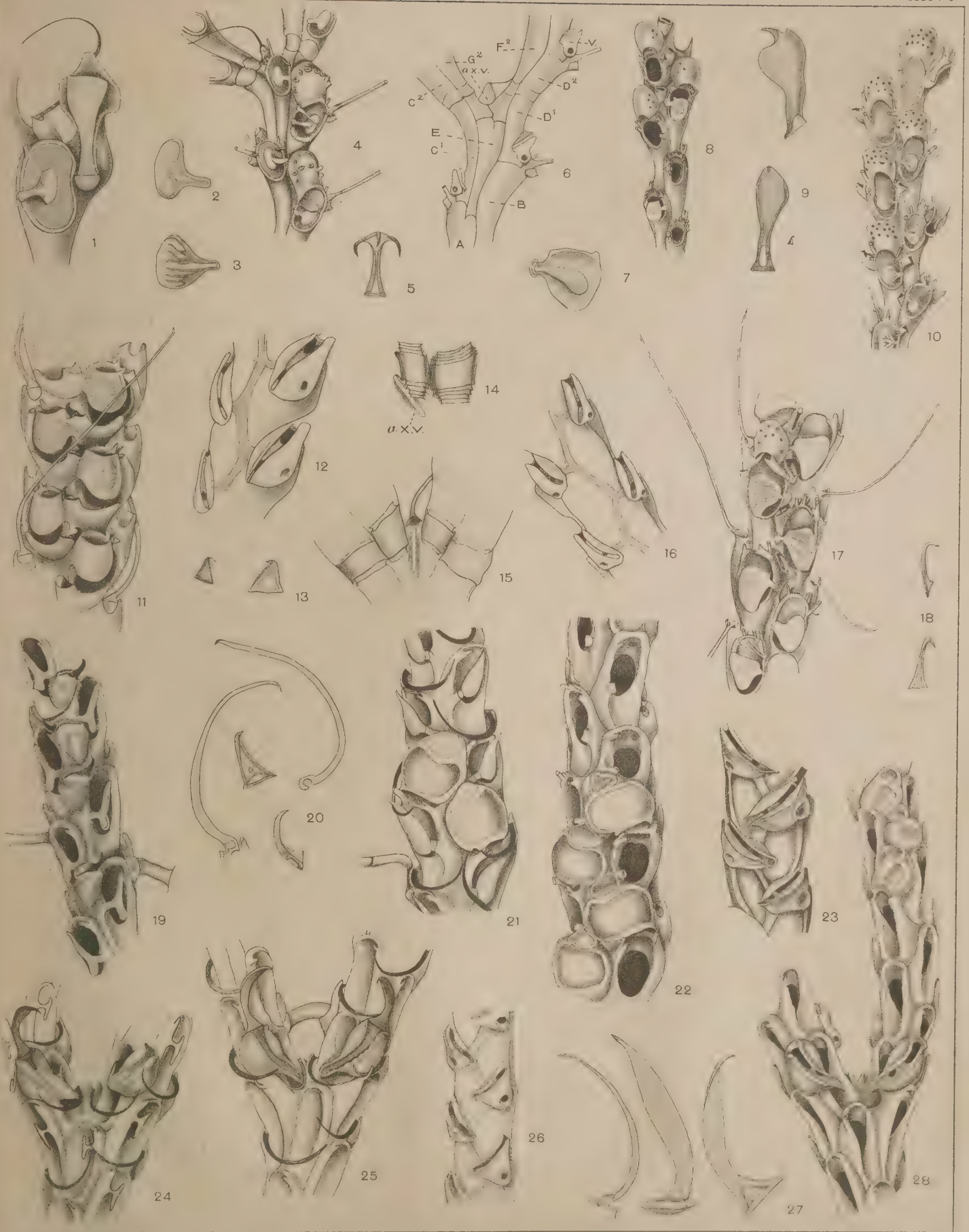
Fig. 24. *Canda pecten* Thorn., var. *scutata* nov. (p. 389). — 181. A, Stat. 260. Zooecia with scuta and vibracula. A large avicularium occurs frontally, on each branch of the bifurcation. Obj. A.

Fig. 25. *Canda pecten* Thorn. (p. 389). — 459. B^2, Stat. 81. Similar branch of the typical form, without scuta. Enlarged frontal avicularia as in fig. 24. Obj. A.

Fig. 26. „ „ „ „ — Same slide. Vibracula, basal view. Obj. A.

Fig. 27. „ „ „ „ — 459. B^3, Stat. 81. One seta (left) and two mandibles. Obj. C.

Fig. 28. „ „ „ „ — 459. B^2, Stat. 81. Cleaned branch with ovicells, vibracula and enlarged frontal avicularia at the bifurcation. Obj. A.



S. F. Harmer del. Fa. P. W. M. Trap impr.

A. 0 10 20 30 40 50 60 70 80 90 100

C. 0 10 20 30 40 50

PLATE XXVII.

EPISTOMIIDAE (*Synnotum*).
BICELLARIELLIDAE (*Calyptozoum*).

Fig. 1. *Synnotum contortum* Waters (p. 396). — 3. A^1, Stat. 7 [1]). Two ordinary internodes and a double internode, in basal view, the middle zooecium a gonozooecium; with sessile avicularia. Obj. C.

Fig. 2. *Synnotum pembaense* Waters (p. 400). — 487. D^1, Stat. 129. Zooecia in frontal view, with pedunculate avicularia. Obj. C.

Fig. 3. *Synnotum aegyptiacum* (Aud.) (p. 398). — 16. B^1, Stat. 49 a. Basal view, showing the three sections of which each zooecium is composed, and sessile avicularia. The uppermost left zooecium of the right branch is a gonozooecium: *x*, the modified proximal sections of the two zooecia succeeding a bifurcation (see text, p. 400). Obj. C.

Fig. 4. „ „ „ „ — Same slide. Frontal view of zooecia, one of which is a gonozooecium, with three sessile and one pedunculate avicularium. Obj. C.

Fig. 5. *Calyptozoum operculatum* n. sp. (p. 430). — 650. A^2, Stat. 211. Bifurcation, frontal view: *av.*, avicularium, reflexed over the opesia; E, axillary zooecium; *r.*, rootlet. Notation of zooecia as in other cases. Obj. A.

Fig. 6. „ „ „ „ — Same slide. Part of a zooecium with an avicularium in the erect position. Obj. C.

Fig. 7. „ „ „ „ — Same slide. Branch with two ovicells; *av.*, avicularium; reflexed; *e.*, egg; *fl.*, flange of avicularium; *m.*, muscle moving avicularium; *ov.*, ovary; *pol.*, polypide; *t.*, testis. Obj. A.

Fig. 8. „ „ „ „ — Same slide. Rootlets, traversed by two oblique joints; the distal joint, uppermost in the figure, broken. Obj. A.

Fig. 9. „ „ „ „ — Same slide. End of a zooecium, with reflexed avicularium. Obj. C.

Fig. 10. „ „ „ „ — Same slide. Fertile zooecium, with ovicell and erect avicularium: *e.*, egg; *ect.*, ectooecium; *ent.*, entooecium; *fl.*, flange of avicularium. Obj. C.

Fig. 11. *Calyptozoum campanulatum* n. sp. (p. 431). — 153. C, Stat. 211. Part of branch at a bifurcation, the zooecia imperfect: E, axillary zooecium; *m.*, muscle moving avicularium; notation of remaining zooecia as in other cases. Obj. A.

Fig. 12. „ „ „ „ — Same slide. Group of rootlets, with two oblique joints. The upper end is distal. Obj. A.

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1) *On p. 397 (explanation of fig. 18), for* 31. A^1 *read* 3. A^1.

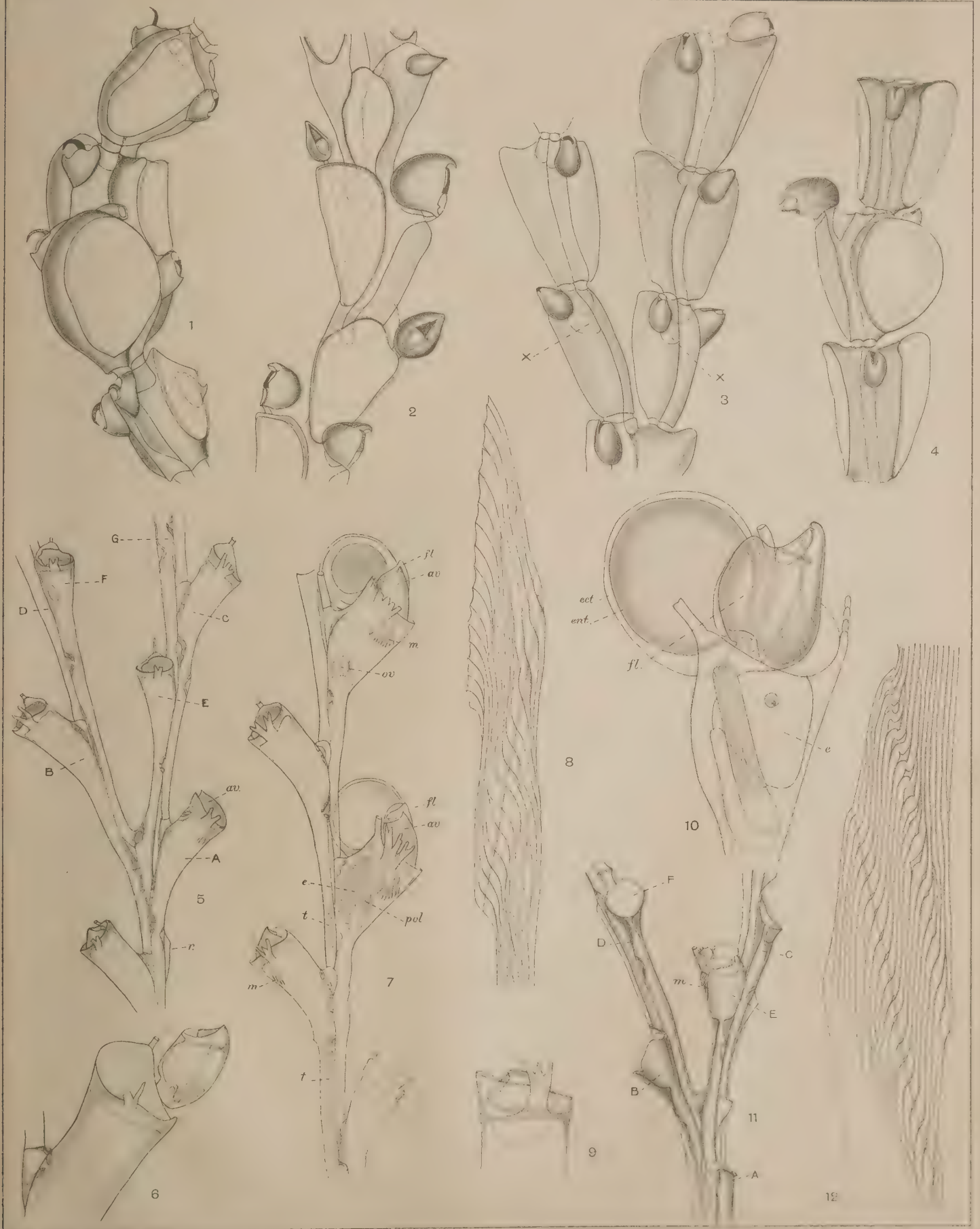

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PLATE XXVIII.

BICELLARIELLIDAE (*Beania*).

Fig. 1. *Beania magellanica* (Busk) (p. 412). — Japan, 48. C (not Siboga Coll.). Zooecium and avicularia. The basal origin of a rootlet is seen through the zooecium. Obj. A.

Fig. 2. „ „ „ „ — Same slide. Basal view of a fertile zooecium showing the vestigial ovicell, connected by a bent tube (*t.*) with the next distal zooecium, at the septum. The origin of a median distal rootlet is seen. Obj. C.

Fig. 3. „ „ „ „ — Same slide. The same in frontal view: *t.* as in fig. 2. Obj. C.

Fig. 4. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 5. *Beania asymmetrica* n. sp. (p. 414). — 327. A^2, Stat. 64. Zooecia, avicularia and well developed ovicells. Obj. A.

Fig. 6. „ „ „ „ — Same slide. Basal view, with rootlets. Obj. A.

Fig. 7. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 8. „ „ „ „ — 327. A^3, .Stat. 64. Distal end of zooecium, with avicularium and ovicell. Not drawn with camera lucida.

Fig. 9. *Beania discodermiae* (Ortm.) (p. 415). — 138. B^1, Stat. 164. One of the avicularia of Fig. 10. Obj. C.

Fig. 10. „ „ „ „ — Same slide. Zooecia and avicularia. Two zooecia show the origin of a basal rootlet, on the deep side of the preparation. Obj. A.

Fig. 11. *Beania regularis* Thorn. (p. 418). — 122. A^2, Stat. 164. Four zooecia, one with two avicularia. Origins of basal rootlets seen through the zooecia. Obj. A.

Fig. 12. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 13. *Beania cupulariensis* Osburn (p. 419). — 62. P, Stat. 99. Avicularium. Obj. C.

Fig. 14. „ „ „ „ — Same slide. Zooecia and avicularia. The median rootlet-bases are seen through the zooecia and, on their outer sides, the bases of lateral connecting processes. Obj. A.

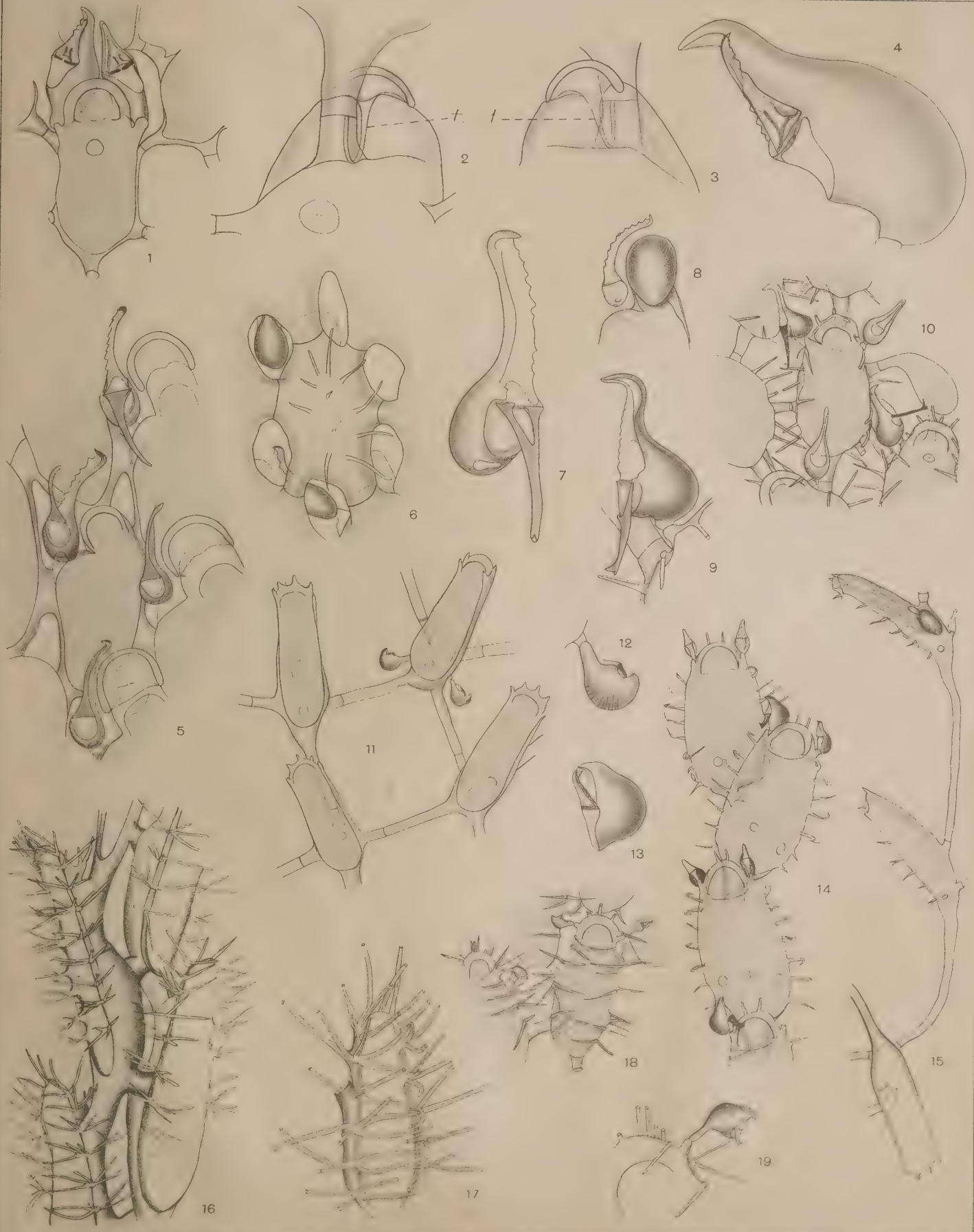
Fig. 15. *Beania mirabilis* Johnst. (p. 419). — 67. H. Stat. 99. Zooecia. Obj. A.

Fig. 16. *Beania hirtissima* (Hell.), var. *cylindrica* Hincks (p. 417). — 331. A^2, Stat. 64. Zooecia. Obj. A.

Fig. 17. „ „ „ „ „ „ „ — 67. D, Stat. 99. Zooecium. Obj. A.

Fig. 18. *Beania petiolata* n. sp. (p. 416). — 394. F, Stat. 144. Zooecia and avicularia. Obj. A.

Fig. 19. „ „ „ „ — Same slide. Part of zooecium, with avicularium. Obj. C.



S. F. Harmer del.

Fa. P. W. M. Trap impr.

PLATE XXIX.

BICELLARIELLIDAE (*Cornucopina*).

Fig. 1. *Cornucopina conica* n. sp. (p. 428). — 146. A^1, Stat. 170. Large avicularium. Obj. C.

Fig. 2. „ „ „ „ — Same slide. Zooecia: *av. t.*, tubercle for attachment of avicularium, seen through the zooecium; *l. r. p.*, lateral rosette-plate; 1, 2, proximal and distal sections of zooecia. Obj. A.

Fig. 3. „ „ „ „ — 526. D^3, Stat. 211. Fertile zooecium, with ovicell, basal view: *t.*, caecal tube passing from ovicell down the basal surface of the zooecium. Obj. A.

Fig. 4. *Cornucopina geniculata* n. sp. (p. 426). — 531. A^1, Stat. 122. Avicularium. Obj. C.

Fig. 5. „ „ „ „ — Same slide. Part of branch, with a bifurcation: E, axillary zooecium; *l. r. p.*, lateral rosette-plates; *tes.*, testis; A to G, as in other cases. Obj. A.

Fig. 6. „ „ „ „ — Same slide. Zooecium with ovicell and avicularium, basal view: *b. b.*, brown body; *c. t.*, calcareous thickenings on basal side of ovicell; *ect.*, ectooecium; *ent.*, entooecium; *l. r. p.*, lateral rosette-plate; *ov.*, ovary; *t.*, tube connecting the first section (1) of the next distal zooecium with the cavity between the two walls of the ovicell; *t. w.*, terminal wall of fertile zooecium; *t. w.*^{1}, its communication with the entooecium; *w.*, widened part of the tube *t.* Obj. C.

Fig. 7. *Cornucopina moluccensis* (Busk) (p. 424). — 499. B^2, Stat. 161. Large avicularium: *p.*, its vestigial polypide. Obj. C.

Fig. 8. „ „ „ „ — 604. A^1, Stat. 177. Another basal avicularium. Obj. C.

Fig. 9. „ „ „ „ — 499. B^2, Stat. 161. Specially enlarged avicularium. Obj. C.

Fig. 10. „ „ „ „ — 604. A^1, Stat. 177. Zooecia with frontal avicularia (*f. av.*); *b. av.*, origin of basal avicularium; *l. r. p.*, lateral rosette-plate. Obj. C.

Fig. 11. *Cornucopina bella* (Busk) (p. 427). — 200. B^1, Stat. 280. Zooecia, avicularia and ovicell. The lowest zooecium has three avicularia. Obj. A.

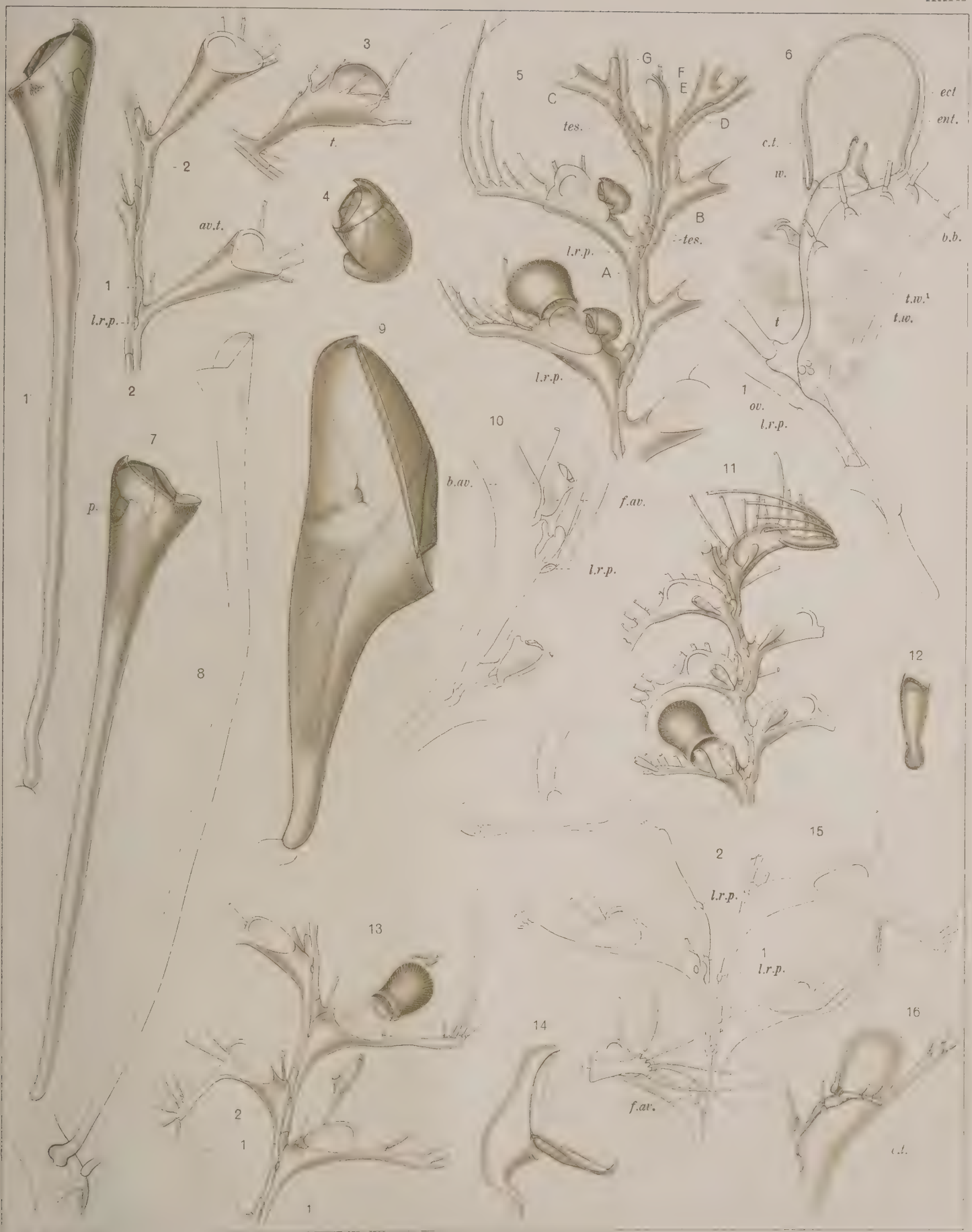
Fig. 12. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 13. *Cornucopina moluccensis* (Busk) (p. 424). — 499. B^2, Stat. 161. Zooecia, ovicell and basal avicularia: 1, 2, proximal and distal sections of zooecium. Obj. A.

Fig. 14. „ „ „ „ — 464. A, Stat. 90. Small avicularium. Obj. C.

Fig. 15. „ „ „ „ — 604. A^1, Stat. 177. Zooecia with one small frontal avicularium (*f. av.*); *l. r. p.*, lateral rosette-plates; 1, 2, proximal and distal sections of zooecium. Obj. A.

Fig. 16. „ „ „ „ — 499. B^2, Stat. 161. Basal view of ovicell; *c. t.*, calcareous thickenings. Obj. A.



S. F. Harmer del.

PLATE XXX.

EUOPLOZOIDAE (*Euoplozoum*).
BICELLARIELLIDAE (*Bugula, Caulibugula*).

Fig 1. *Euoplozoum cirratum* (Busk) (p. 391). — 536. B^1, Stat. 227. Proximal part of colony showing a large dilatation of the primary rootlet. Obj. A.

Fig. 2. „ „ „ „ — 526. B^1, Stat. 211. Zooecia and avicularia, basal view: *a, b* and *c*, the three sections of a zooecium. Obj. A.

Fig. 3. „ „ „ „ — Same slide. Bifurcation, with ovicell, frontal view: *av.*, base of avicularium, seen through fertile zooecium; E, axillary zooecium; *f. m.*, flexor muscle of fertile zooecium; *f.* m^1, *f.* m^2, larger and smaller flexors of ordinary zooecium; *ov.*, ovary; *pol.*, polypide (tentacles of); *t.*, terminal hooked end of zooecium; t^1, corresponding part of the zooecia A, B and C at the bifurcation; *tes.*, testis. Obj. A.

Fig. 4. „ „ „ „ — Same slide. Zooecia, one with an enlarged avicularium, in addition to the normal marginal avicularium. Obj. A.

Fig. 5. *Bugula dentata* (Lamx) (p. 439). — 89. C^1, Stat. 116. Distal end of a zooecium, with jointed spines. Obj. C.

Fig. 6. „ „ „ „ — Same slide. Zooecium, ovicell and avicularium; *p.*, large pore. Obj. C.

Fig. 7. *Bugula cucullata* Busk (p. 447). — 541. E^1, Stat. 257. Basal view, with avicularium and ovicells. Obj. C.

Fig. 8. *Bugula longicauda* n. sp. (p. 450). — 656. A^2, Stat. 170. Zooecia, three with vestigial ovicells (*ovc.*): *b. w.*, insertion of inner branch of proximal fork into basal wall of preceding zooecium; *c. p.*, connecting process of the axillary zooecium (E); *f.*, foramen by which the cavity between the two layers of the ovicell communicates with the body-cavity of the distal zooecium; *ov.*, ovary. Obj. A.

Fig. 9.
Fig. 10. } *Bugula philippsae* n. sp. (p. 437). — 41. A^1, Stat. 77. Proximal part of a colony, Fig. 9 being a continuation of Fig. 10. A, B, the two zooecia of an incomplete branch; 1—10, successive kenozooecia or zooecia of the stem. Obj. A.

Fig. 11. *Caulibugula inermis* n. sp. (p. 467). — 336. E, Stat. 37. Zooecia, with two bifurcations. Obj. A.

Fig. 12. „ „ „ „ — 1. B, Stat. 7. Kenozooecia of stem. Obj. A.

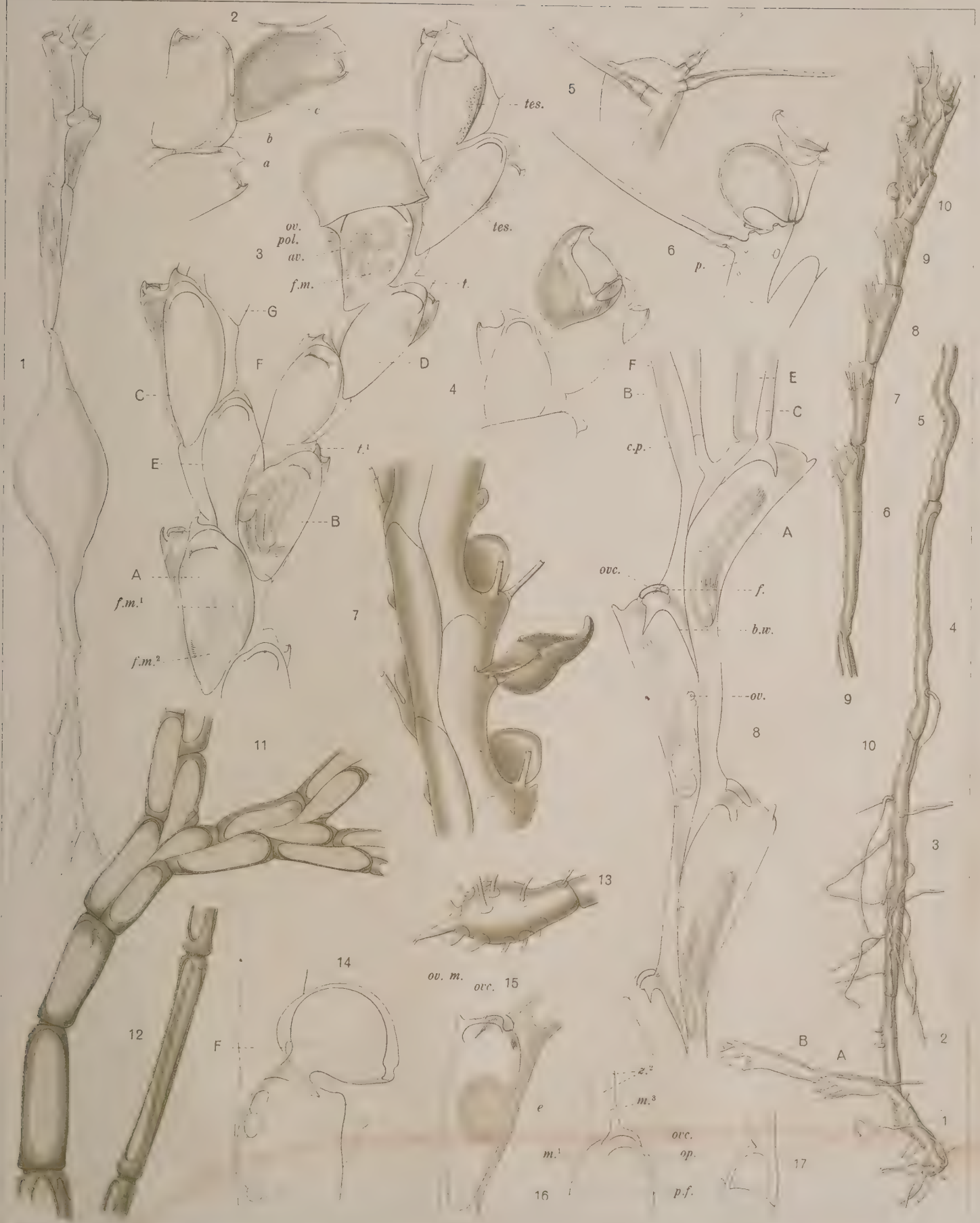
Fig. 13. „ „ „ „ — 400. E, Stat. 164. Primary dilated rootlet, giving off secondary rootlets. Obj. C.

Fig. 14. *Bugula johnstonae* (Gray) (p. 448). — 92. C, Stat. 117. Fertile zooecium and ovicell in side view: *f.*, foramen by which the cavity between the two layers of the ovicell communicates with the body-cavity of the distal zooecium. A large egg is seen in the body-cavity. Obj. C.

Fig. 15. *Bugula longicauda* n. sp. (p. 450). — 152. A^1, Stat. 211. Fertile zooecium, with the vestigial ovicell (*ovc.*); *e.*, egg; *ov. m.*, muscle of ovicell. Obj. A.

Fig. 16. „ „ „ „ — Japan, 21. A (not Siboga Coll.). Similar preparation, showing the complete continuity of the cavity of the ovicell with the body-cavity of the distal zooecium: m^1, inner margin of fertile zooecium, overlapping the zooecia of the other side of the branch; m^3, corresponding margin of the next distal alternate zooecium; *op.*, operculum; *ovc.*, vestigial ovicell; *p. f.*, proximal fork of the next succeeding zooecium (z^2). Obj. A.

Fig. 17. *Bugula* sp. (allied to *B. longicauda*) (p. 451). — Japan, 27. C (not Siboga Coll.). Well developed entozooecial ovicell, the cavity between its two layers continuous with the body-cavity of the succeeding zooecium. Obj. A.



S. F. Harmer del

A 0 10 20 30 40 50 60 70 80 90 100

C 0 10 20 30 40 50

PLATE XXXI.

BICELLARIELLIDAE (*Bicellariella*, *Bugula*).

Fig. 1. *Bugula vectifera* n. sp. (p. 442). — 37. X, Stat. 77. Zooecia at bifurcation, and avicularia. Obj. A.

Fig. 2. „ „ „ „ — 600. C., Stat. 77. Bifurcation, frontal view: *c.p.*, connecting process of zooecium F; E, axillary zooecium. Notation of remaining zooecia as in other cases. Obj. A.

Fig. 3. „ „ „ „ — Same slide. A proximal stem-zooecium, showing rootlets. Obj. C.

Fig. 4. „ „ „ „ — 637. A, Stat. 2. Part of zooecium, with ovicell and avicularium. Obj. C.

Fig. 5. „ „ „ „ — Same slide. Ovicell, side view. Obj. C.

Fig. 6. „ „ „ „ — 600. C, Stat. 77. Bifurcation, in the region of the main stem, basal view: *a*, *b*, parts of the calcareous bars ($c.b^1$, $c.b^2$); *c.p.*, connecting process, at bifurcation; E, axillary zooecium; *l.s.*, longitudinal calcareous septum between the zooecia of the two sides; *t.*, oblique terminal wall. Obj. C.

Fig. 7. *Bugula scaphoides* Kirkp. (p. 443). — 138. A^1, Stat. 164. Zooecia, avicularia and ovicells. Obj. A.

Fig. 8. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 9. *Bugula mollis* n. sp. (p. 445). — 130. D, Stat. 164. First zooecium of a colony. Obj. A.

Fig. 10. „ „ „ „ — 596. A^1, Stat. 164. Zooecia, avicularia and vestigial ovicells (*ovc.*). Obj. C.

Fig. 11. „ „ „ „ — 130. D, Stat. 164. Bifurcation, basal view; *c.p.*, connecting process of axillary zooecium (E). Obj. A.

Fig. 12. *Bugula dispar* n. sp. (p. 446). — 37. V, Stat. 77. Bifurcation, basal view: E, axillary zooecium. Obj. A.

Fig. 13. „ „ „ „ — Same slide. Zooecia, avicularia (one enlarged) and ovicells: — *ovc.*, *ovc.*^{1}, calcareous parts of the vestigial ovicells; *ves.*, membranous vesicle of ovicell. Obj. A.

Fig. 14. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 15. „ „ „ „ — Same slide. Mandible of enlarged avicularium. Obj. C.

Fig. 16. „ „ „ „ — Same slide. Enlarged avicularium. Obj. C.

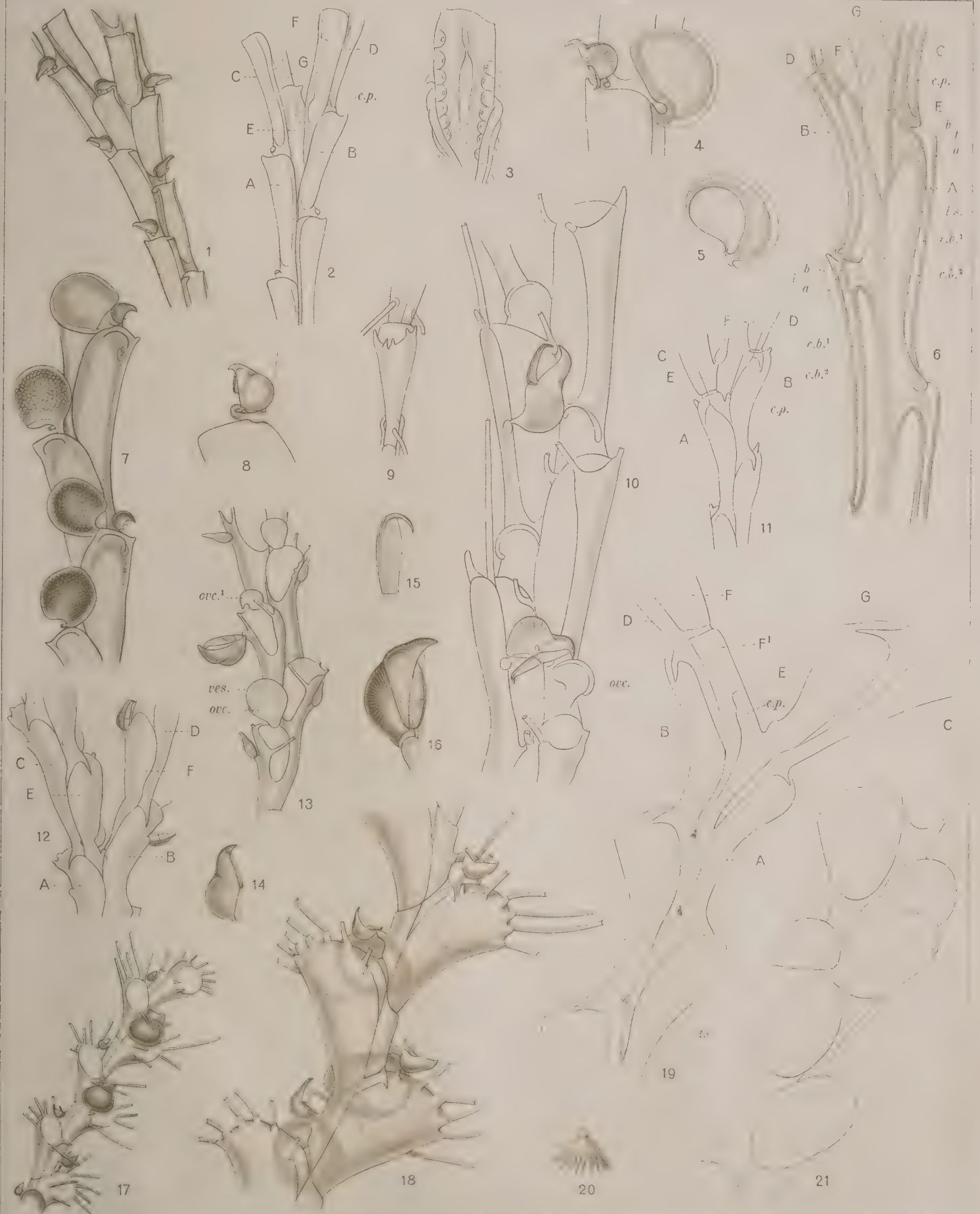
Fig. 17. *Bicellariella levinseni* n. sp. (p. 421). — 16. D^1, Stat. 49^a. Zooecia, avicularia and ovicells. Obj. A.

Fig. 18. „ „ „ „ — Same slide. Basal view of zooecia, showing the three sections of which they are composed, with avicularia and ovicells. Obj. C.

Fig. 19. *Bugula johnstonae* (Gray) (p. 448). — 92. C, Stat. 117. Bifurcation, basal view: *c.p.*, connecting process of the axillary zooecium (E); *t.c.*, dentate calcifications in the body-cavities. Obj. A.

Fig. 20. „ „ „ „ — Same slide. Dentate calcification, more highly magnified. Obj. C.

Fig. 21. „ „ „ „ — Same slide. Zooecia with ovicells. Obj. A.



S. F. Harmer del.

PLATE XXXII.

BICELLARIELLIDAE (*Bugula*).

Fig. 1. *Bugula robusta* MacGill. (p. 435). — 287. A[1], Stat. 61. Zooecia, avicularia and ovicells. Obj. A.

Fig. 2. „ „ „ „ — 102. A[1], Stat. 133. Zooecium, ovicell and avicularium, borne on a long peduncle. Obj. A.

Fig. 3. „ „ „ „ — 118. A[2], Stat. 164. Zooecia, avicularia and ovicells. The cusps of the avicularian rostra are evanescent. Obj. A.

Fig. 4. „ „ „ „ — 37. Y, Stat. 77. Bifurcation, basal view: *c.p.*, connecting process of the zooecium G; E, axillary zooecium. The full length of the median calcareous spines is not drawn, in most cases. Obj. A.

Fig. 5. „ „ „ „ — 287. A[1], Stat. 61. Basal view, showing the strongly marked septal lines. The median calcareous spines are shorter than in fig. 4. Obj. A.

Fig. 6. „ „ „ „ — Same slide. Oblique side view of a zooecium, showing the septula. Obj. A.

Fig. 7. „ „ „ „ — 37. Y, Stat. 77. Avicularium. Obj. C.

Fig. 8. *Bugula philippsae* n. sp. (p. 437). — 263. A, Stat. 319. Zooecia, avicularia and ovicells. Obj. A.

Fig. 9. „ „ „ „ — 41. A[1], Stat. 77. Bifurcation, basal view: *c.p.*, connecting process of zooecium G; E, axillary zooecium. Obj. C.

Fig. 10. „ „ „ „ — Same slide. Distal end of zooecium, with spines. Obj. C.

Fig. 11. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 12. *Bugula pedata* n. sp. (p. 441). — 418. A[3], Locality not recorded. Proximal end of rootlet, showing its foot-like termination. Obj. A.

Fig. 13. „ „ „ „ — 418. A[1], same material. Bifurcation, frontal view: *c.p.*, connecting process of the zooecium F; E, axillary zooecium. Obj. A.

Fig. 14. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 15. *Bugula subglobosa* n. sp. (p. 444). — 92. E[1], Stat. 117. Ovicell, frontal view. Obj. C.

Fig. 16. „ „ „ „ — Same slide. Ovicell, from distal side. Obj. C.

Fig. 17. „ „ „ „ — 92. E[1], Stat. 117. Bifurcation, frontal view, with avicularia and ovicell: *c.p.*, connecting process of zooecium F; E, axillary zooecium. Obj. A.

Fig. 18. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 19. *Bugula cucullata* Busk (p. 447). — 541. E[1], Stat. 257. Zooecia, avicularia and cucullate ovicells. Obj. A.

Fig. 20. „ „ „ „ — Same slide. Avicularium. Obj. C.

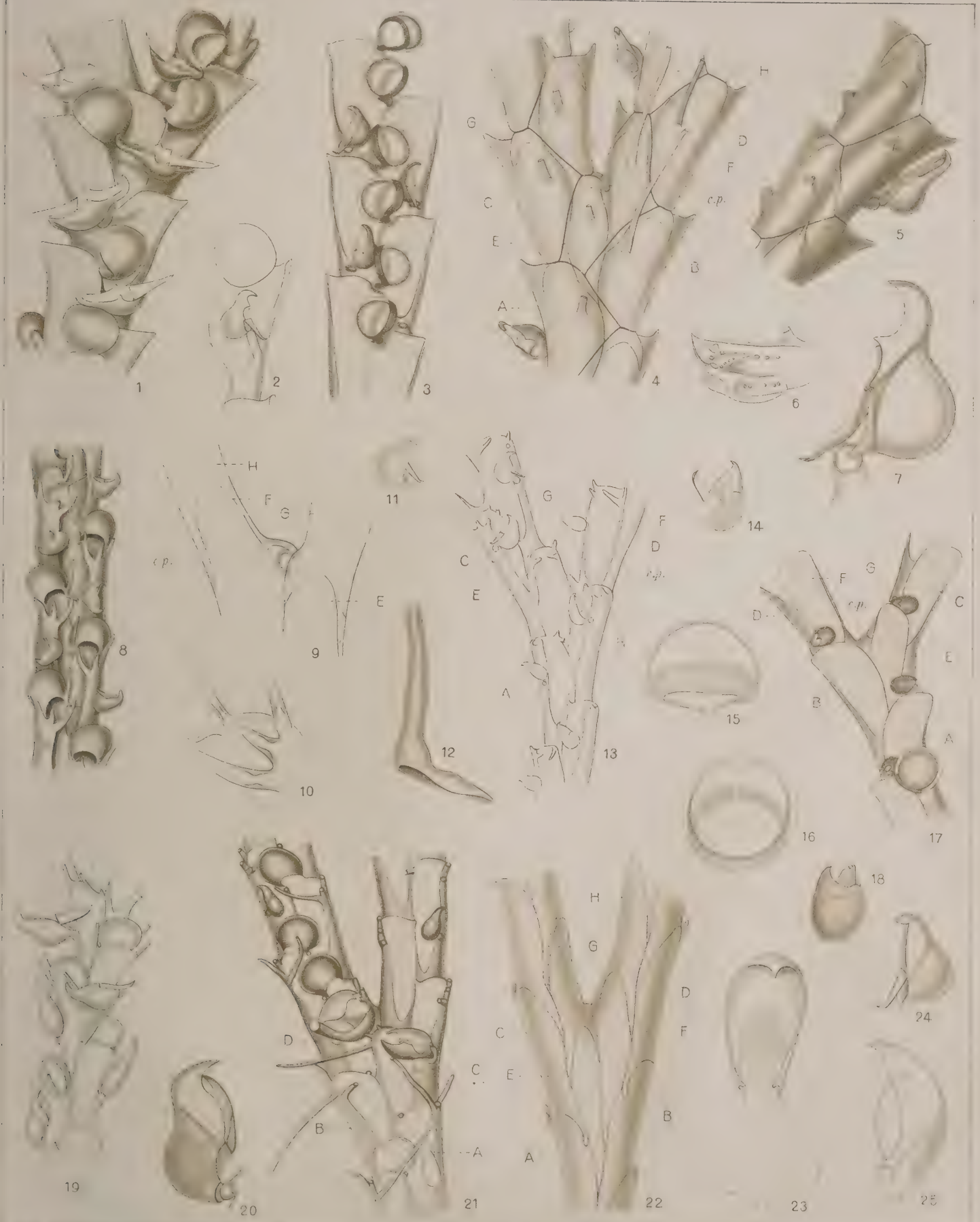
Fig. 21. *Bugula dentata* (Lamx) (p. 439). — 89. C[1], Stat. 116. Bifurcation, frontal view. Two avicularia at the bifurcation are enlarged and modified. Ovicells occur on the left branch. Obj. A.

Fig. 22. „ „ „ „ — Same slide. Bifurcation, basal view. Obj. A.

Fig. 23. „ „ „ „ — Same slide. Enlarged avicularium, from a bifurcation. Obj. C.

Fig. 24. „ „ „ „ — Same slide. Ordinary avicularium. Obj. C.

Fig. 25. „ „ „ „ — Same slide. Enlarged, modified avicularium. Obj. C.



S. F. Harmer del.

PLATE XXXIII.

BICELLARIELLIDAE (*Caulibugula*).

Fig. 1. *Caulibugula dendrograpta* (Waters) (p. 459). — 16. E, Stat. 49a. Part of a colony, showing the primary, *Bicellariella*-like zooecium of a fan, and the commencement of the stalk of another fan. Obj. A.

Fig. 2. " " " " — Same slide. Bifurcation, basal view, showing joints and the connecting process (*c.p.*) of zooecium F, meeting the proximal end of G across the axillary zooecium, E. Avicularia occur on two zooecia. Obj. A.

Fig. 3. " " " " — 396. Q^1, Stat. 162. Part of the stolon-like attaching base, formed of kenozooecia. Obj. A.

Fig. 4. " " " " — 16. E, same colony as Figs 1, 2. Avicularium. Obj. C.

Fig. 5. *Caulibugula zanzibariensis* (Waters) (p. 460). — 16. E, same slide as Figs 1, 2, 4. Zooecial fan, with modified proximal zooecium, and end of last kenozooecium of its stalk. Obj. A.

Fig. 6. " " " " — 376. F, Stat. 213. Zooecium with rootlet and ovicell. Obj. A.

Fig. 7. " " " " — Same slide. Another fertile zooecium, the ovicell nearly in side view. Obj. A.

Fig. 8. " " " " — 16. E, same slide as Figs 1, 2, 4, 5. Part of a branch, with avicularia. Obj. A.

Fig. 9. " " " " — 376. F, Stat. 213. Parts of zooecia, with avicularium. Obj. C.

Fig. 10. " " " " — 1. A, Stat. 7. Parts of two kenozooecia, one with a group of stem-vesicles near its distal end. A Foraminiferan is seen on the vesicles. Obj. A.

Fig. 11. *Caulibugula exilis* (MacGill.) (p. 462). — 396. U^1, Stat. 162. Avicularium. Obj. C.

Fig. 12. " " " " — 396. U^2, Stat. 162. Ovicell, side view. Obj. A.

Fig. 13. " " " " — Same slide. Stolon-like attaching base, consisting of irregular kenozooecia, giving off erect stems. Obj. F. 55 (Greenough).

Fig. 14. " " " " — The portion *a*—*a* of Fig. 13, more highly magnified. Obj. A.

Fig. 15. " " " " — 396. U^1, Stat. 162. End of stalk and part of a zooecial fan, with three avicularia. Obj. A.

Fig. 16. " " " " — Same slide. Bifurcation, basal view. The connecting process is formed by the zooecium G and joins H: E, axillary zooecium. Obj. A.

Fig. 17. *Caulibugula separata* n. sp. (p. 464). — 39. B, Stat. 77. Bifurcation, basal view, showing joints and an avicularium. The connecting process is formed by the zooecium C, and joins the proximal end of D. Obj. C.

Fig. 18. " " " " — Same slide. Bifurcation, frontal view. Obj. A.

Fig. 19. *Caulibugula mortenseni* (Marcus) (p. 465). — 555. F^1, Stat. 320. Kenozooecium, with rootlets, some of which are modified as vesicles. Obj. A.

Fig. 20. " " " " — Same slide. Bifurcations, with avicularia, frontal view. Obj. A.

Fig. 21. " " " " — Same slide. Ovicell. Obj. A.

Fig. 22. " " " " Same slide. Avicularium. Obj. C.

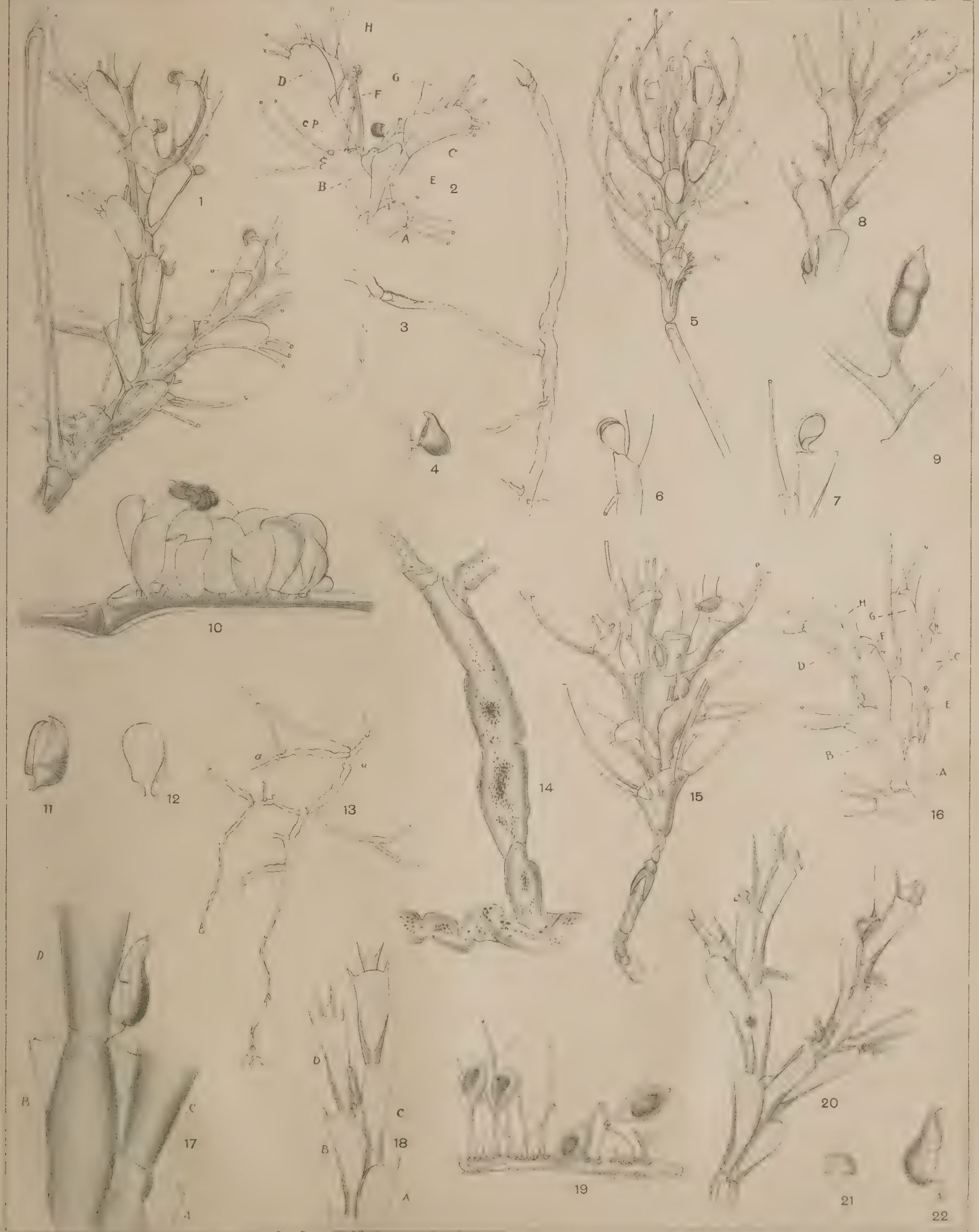


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PLATE XXXIV.

MEMBRANIPORIDAE (*Hiantopora*).
BICELLARIELLIDAE (*Camptoplites, Kinetoskias*).
CRIBRILINIDAE (*Membraniporella, Colletosia, Figularia*).

Fig. 1. *Hiantopora intermedia* Kirkp. (p. 237). — 225. A^1, Stat. 305. Zooecia, separated by fenestrae, with avicularia and branched spines, forming the commencement of a frontal shield. Obj. A.

Fig. 2. „ „ „ „ — Same slide. Basal view, showing fenestrae and delicate, calcified rootlets. Obj. A.

Fig. 3. „ „ „ „ — S. Australia, Dr. J. C. VERCO, Mus. Cambridge (not Siboga Coll.). Side view of a zooecium and parts of two others, showing rosette-plates, spines and an avicularium (*av*). Obj. A.

Fig. 4. *Hiantopora radicifera* (Hincks) (p. 236). — Victoria, Miss E. C. JELLY, Mus. Cambridge. Zooecia and avicularia, the lateral spines bifurcate. Obj. A.

Fig. 5. *Camptoplites lunatus* n. sp. (p. 452). — 628. C^1. Stat. 295. Proximal zooecium. Obj. A.

Fig. 6. „ „ „ „ — Same slide. Zooecia and avicularia, the stalks of which are distorted by the action of reagents. Obj. A.

Fig. 7. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 8. „ „ „ „ — Same slide. Bifurcation, basal view: *c.p.*, connecting process; E, axillary zooecium. For explanation see text. Obj. A.

Fig. 9. *Kinetoskias elongata* n. sp. (p. 469). — 530. C^1, Stat. 221, part of Fig. 11, more highly magnified. Avicularium. Obj. C.

Fig. 10. „ „ „ „ — Same slide. Bifurcation, basal view; *d*, calcareous ring at proximal end of zooecium; *l.r.p.*, lateral rosette-plate; E, axillary zooecium, showing a retractor muscle of the polypide. The flexors of the zooecia are seen in C, D, G and its neighbour. Obj. A.

Fig. 11. „ „ „ „ — Same slide. Zooecia, avicularia and ovicell: Ov^1., egg in ovicell; Ov^2., egg in body-cavity. Obj. A.

Fig. 12. *Membraniporella aragoi* (Aud.) (p. 473). — 323. G, Stat. 50. Zooecia and ovicell, young state. Obj. A.

Fig. 13. „ „ „ „ — Same slide. Zooecium and ovicell, young state. Obj. A.

Fig. 14. „ „ „ „ — 447. B, Stat. 59. Zooecia and ovicell, old state. Obj. A.

Fig. 15. *Colletosia radiata* (Moll) (p. 475). — 131. G, Stat. 164. Two zooecia, avicularium and ovicell. Obj. A.

Fig. 16. „ „ „ „ — 249. M, Stat. 310. Zooecium. Obj. A.

Fig. 17. „ „ „ „ — Same slide. Avicularium. Obj. C.

Fig. 18. „ „ „ „ — 131. G, Stat. 164. Two kinds of avicularia. The left avicularium is of the form described as characteristic of var. *flabellifera* Kirkp. Obj. C.

Fig. 19. *Figularia fissa* (Hincks) (p. 478). — 249. A^3, Stat. 310. Operculum and two mandibles. Obj. C.

Fig. 20. „ „ „ „ — 38. N^1, Stat. 77. Two zooecia with greatly reduced costal areas. Obj. A.

Fig. 21. „ „ „ „ — Same slide. Two zooecia, the costal areas not quite so much reduced. Obj. A.

Fig. 22. „ „ „ „ — 249. A^1, Stat. 310. Two zooecia, and vicarious avicularium. Obj. A.

Fig. 23. „ „ „ „ — Same slide. Zooecia, ovicells and avicularia, which vary in size. Obj. A.

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